EIS 565

AB019250

Lucky Draw Gold Project : earthworks specification

LUCKY DRAW GOLD PROJECT

EARTHWORKS SPECIFICATION

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INFORMATION FOR TENDERERS
Geotechnical Report by Douglas and Pontres

EARTHWORKS SPECIFICATION

1 EXTENT OF WORK

1.1 General

Work included in the earthworks section of the project is as follows:

- borrow pit
- dump pad and ramp
- the tailings dam
- haul road to the tailings dam
- silt collection dams
- tailings embankment runoff pond
- plant runoff pond
- Moss Grove Road deviation.

The scope is specified in more detail below.

1.2 Dump pad and ramp

The work includes:

- clearing
- stripping topsoil
- spreading and compacting mine waste
- spreading and compacting fill under bridge support.

1.3 Haul road

The work includes:

- clearing and grubbing
- stripping topsoil
- earthworks
- preparing subgrade
- pavement construction
- culverts
- fencing.

1.4 Tailings dam

The work includes:

- clearing and grubbing
- stripping topsoil
- preparing dam foundations
- embankment construction
- compaction of disposal area floors
- drainage and monitoring works.

This work is to be done progressively to suit availability of mine waste and materials for embankment construction and the need to contain tailings over the life of the operation.

1.5 Tailings embankment runoff pond

The work includes:

- clearing and grubbing
- stripping topsoil
- preparing dam foundations
- pond excavation
- embankment construction
- spillway
- drainage facilities.

1.6 Plant runoff pond

The work includes:

- clearing and grubbing
- stripping topsoil
- preparing dam foundations
- pond excavation
- embankment construction
- pond floor construction
- overflow spillway construction.

1.7 Silt collection dams

The work includes:

- stripping vegetation and topsoil
- preparation of embankment foundations
- excavation of pond area
- embankment construction
- drainage facilities.

1.8 Moss Grove Road deviation

The work includes:

- stripping
- earthworks and formation
- pavement
- culverts and drainage
- fencing.

2 STANDARDS

Standards used for earthworks compaction shall be AS 1289 Methods of Testing Soil for Engineering Purposes. Unless specified otherwise all compaction densities referred to in this specification will be based on the standard method in accordance with AS 1289 Section E.1.1.

3 CLASSIFICATION OF MATERIALS

For this earthworks specification the various materials are defined as follows:

- Top soil:- the surface 100 mm to 200 mm material containing humus.
- Surface clays:- clay, sandy clay, gravelly clay generally within 2 m of surface in the mine and other areas.
- Weathered rock:- weathered material or oxide mine waste generally between 2 m and 40 m from the surface.
- Fresh rock:- fresh rock or primary mine waste generally below 40 m from the surface.

The Superintendent shall confirm the actual type of material for construction purposes during the course of the work.

4 BORROW PIT

A borrow pit for haul road pavement and other selected fill requirements shall be developed in the tailings disposal area as indicated on the drawings.

The Contractor shall clear, strip top soil and surface clays to expose silstone. Clay material shall be stockpiled nearby for later sealing the borrow pit floor.

Borrow material is siltstone or weathered rock all capable of being ripped by a Caterpiller D9 dozer or equivalent.

5 PLUGGING DRILL HOLES

Before commencement of work in the tailings dam area, the Contractor shall fill investigation drill holes with concrete and backfill any pits through the clay blanket with Zone 1 material.

The Superintendent shall be responsible for locating the drill holes and pits.

6 CLEARING AND GRUBBING

All trees, roots and vegetation shall be stripped from the designated works area and disposed of by burning or other approved means.

The Contractor shall be responsible for ensuring all burning operations are carried out in accordance with the statutory regulations in force.

Where removal of roots creates a hole in the clay blanket in the floor of the tailings disposal area the hole shall be refilled with material to Zone 1 specifications.

7 STRIPPING TOPSOIL

Topsoil shall be stripped from the designated areas.

The excavated topsoil shall be stockpiled in areas shown on the drawings or within 500 m of the site where directed by the Superintendent. Stockpiles shall be smoothed to a measurable outline of a regular shape.

8 DUMP PAD AND RAMP

Clearing and stripping

The dump pad and ramp area shall be cleared and stripped as specified in Sections above.

Bridge support

Fill under the dump bridge support shall be weathered rock from the borrow pit or mine waste. The material shall be conditioned, spread and compacted in layers to a uniform density of 100 per cent relative density.

Pad and ramp

The remainder of the pad and ramp shall be built up in horizontal layers from mine waste filled in the sequence specified below:

- Top surface 1,200 mm (minimum depth):
  - weathered rock from mine waste compacted to 95 relative density.
- Below 1,200 mm from surface:
  - clayey mines waste from the top 2 m of the mine area or weathered rock from the mine waste compacted by traffic or compactors to 90 per cent relative density.

Batters shall be trimmed and compacted.

9 HAUL ROAD

9.1 Earthworks and pavement

The haul road shall be located as shown on the drawings.

The formation shall be cleared and stripped as specified above.

The road shall be excavated and filled as indicated on the drawings or directed on site.

The Contractor shall excavate in all materials encountered. Materials for excavation will not be classified for the purpose of payment.

Fill and pavement material shall be weathered rock from the borrow pit, spread in layers, conditioned and compacted to 100 per cent relative density. Large particles shall be raked to the edges.

9.2 Culverts

Culverts shall be class Y butt-jointed reinforced concrete pipes laid and bedded and surrounded with 150 mm of compacted fine weathered rock.

10 TAILINGS DAM CONSTRUCTION

10.1 General

The tailings dam embankment is to be constructed from selected mine waste material placed in accordance with this specification.

Testing of the excavated mine waste material and the construction quality in the embankment by an independent N.A.T.A. registered testing authority will be required. It will be the Superintendent's responsibility to nominate and provide the testing in accordance with the requirements of this specification.

Work quality which fails to comply with specification requirements shall be repaired at the Contractor's cost.

The Superintendent shall be responsible for planning and programming waste production and programming the embankment staging requirements.

The Contractor shall be responsible for all associated works to ensure staging programmes can be achieved and ensuring his mining method can produce suitable materials required for construction as specified herein.

10.2 Construction - Stage 1

10.2.1 Base preparation

The dam foundation shall be prepared by removing all silty, sandy material overlying the clay and any soft yielding clay. The contractor shall ensure the excavation is drained and cannot pond water at all times.

The subgrade shall be inspected and approved by the Superintendent and any approving authority before any filling or preparation commences.

The approved subgrade shall be compacted with a minimum of six passes of a Caterpillar 815 compactor or equivalent or until there is no further compaction of the material visible. Sections of floor which are to be recompacted, as specified below, shall be completed under the dam as indicated on the drawings.

10.2.2 Zone 1

Material

Zone 1 shall comprise clay, sandy clay or gravelly clay from mine stripping or pond excavations. The most highly weathered rock may also be used for Zone 1 if it compacts to an impervious material of $k=10^{-8}$ m/sec or less.

Construction

The material shall be spread in layers not exceeding 200 mm compacted thickness or whatever thickness will allow uniform compaction to the specified densities.

Materials shall be thoroughly mixed and moisture conditioned before compaction.

Moisture content of the material shall be controlled to within 2 per cent of optimum. Any excess moisture shall be removed by harrowing or other means to dry the material. If in the opinion of the Superintendent any material in the bank which cannot conveniently be brought to specified moisture content, shall be removed.

Compacted material which has been allowed to dry and crack shall be removed and replaced at the Contractors cost.

Zone 1 material shall be compacted to a relative density of 98 per cent.

10.2.3 Zone 2

Material

Zone 2 material shall comprise selected weathered rock from the mine waste.

Alternative Zone 2 material is weathered siltstone or sandstone obtainable from the tailings disposal area generally below approximately 1 m from the surface.

The material and suitable borrow locations shall be identified by the Superintendent.

Construction

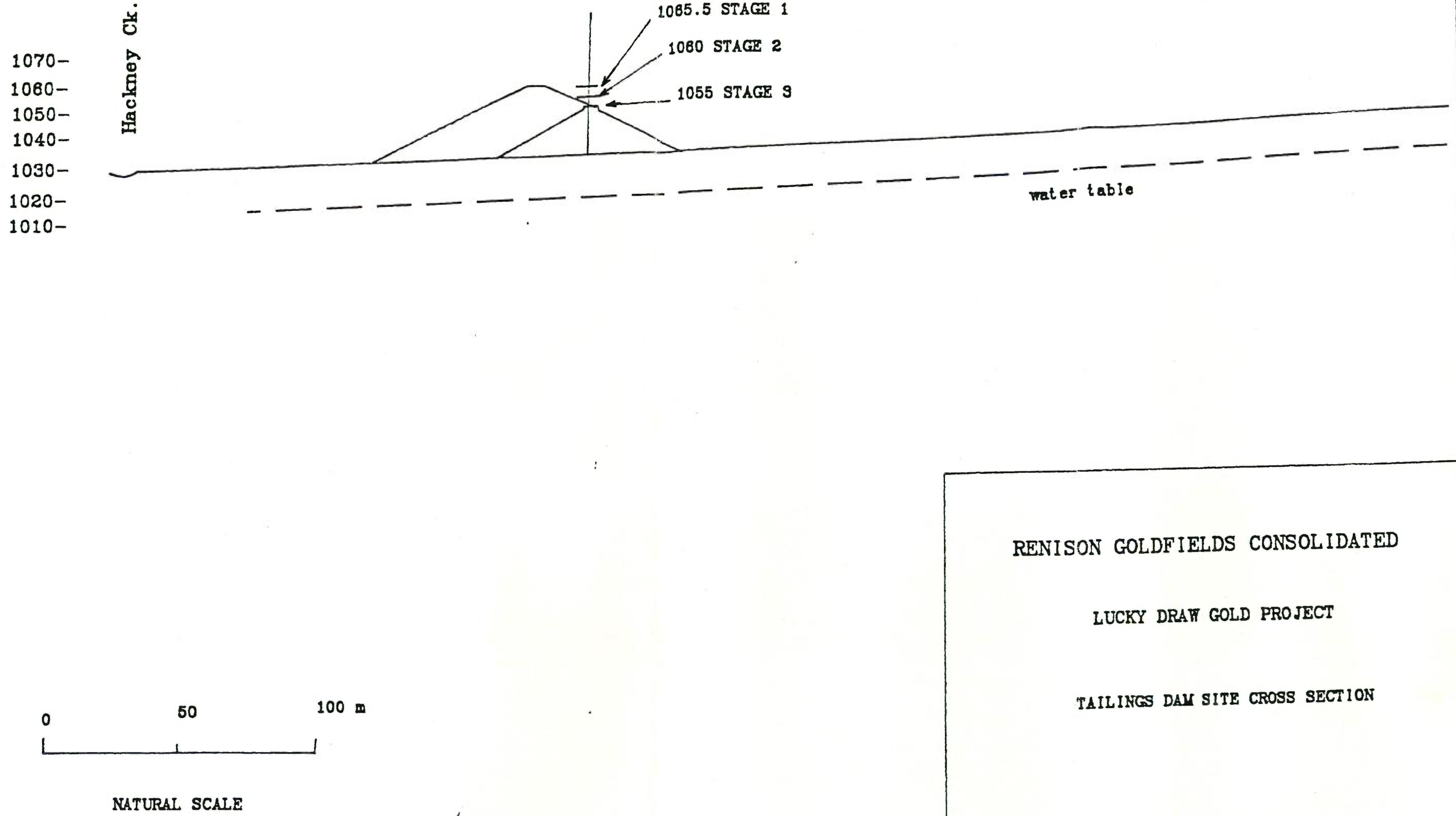
Zone 2 material shall be spread in layers and compacted as specified for Zone 1.

Any large, hard particles shall be raked to the outside batters.

10.2.4 Zone 3 and 3a

Material

Zone 3 material shall be selected fresh, hard, durable free draining rock from the primary mine waste.



RENISON GOLDFIELDS CONSOLIDATED

LUCKY DRAW GOLD PROJECT

TAILINGS DAM SITE CROSS SECTION

by AUSTRALIAN GROUNDWATER CONSULTANTS

FIG. 6

APPENDIX I

REGISTERED BORE RECORDS

58.9 61.00 SCST 1

CODE 73A7 DEPTH GIVEN 61.00 METRES

H4

PRINT: 06/11/87 WATER RESOURCES COMMISSION PAGE: 26685

MAP NO: 57C4 BOREMASTER/LITHOLOGY PRINTOUT - PROGRAM: WCBL30 57C4 54808

*** BORE NO: 54808 (57C4) ***

BOREMASTER DATA ** PAPERS: V117921 ** ALT DATE: 01/11/83 **

COUNTY : GEORG MAP : 1:31680 N SURFACE RL: YIELD: 1.500 L/S SWL: 9.1 M S: EXP
PARISH : 40 ZONE : 08 (2) EQUIP: AIRLIFT DDL:
PORTION: 220 EAST : 250310 TOT DEPTH : 30.4 M DATE :11/02/1981 TOT DEPTH: 30.4 M T: EXP
R-BASIN: 421 NORTH: 815770 COMPLETED : 02-1981 TIME : HRS PUMP AT:

LIC:117921 NAME: JONES PERIOD: PP EXPIRY: PP/PP/PP LICAM1: LICAM2:

LOGS : DRILLER PROPOSED USE: STOCK & DOMESTIC CONTRACTOR: PRIVATE TYPE : B OPEN THRU ROCK
MEAS : PRESENT USE : STOCK & DOMESTIC OWNER : PRIVATE METHOD: ROTARY AIR
SETTING: SALINITY : DRILLER : DALT STATUS:

	DIAM	TOP	LTH/THK	TYPE	DESCRIPTION/SALINITY	APTR/SIZE	SWL	YIELD	ALT DATE SH NO
CASING:	162 MM	0.0 M	9.4 M	WELDED STEEL	DRVN SMALL HOLE				1 01
AQUIFER:		11.5 M	0.6 M	FRACTURED			9.1 M	1.500 L/S	1 01

** DRILLER'S LOG **

C = CONFIDENCE LEVEL G = GRAINSIZE E = 1 = WATER SUPPLY W = WEATHERING

THICK	BASE		CGEW	DESCRIPTION	COLOUR	FORM
0.60	0.60	TPSL	9			
8.20	8.80	CLAY		AND SHLE		
21.6	30.40	BSLT	1			

CODE HIP4 DEPTH GIVEN 30.40 METRES

*** BORE NO: 55370 (57C4) ***

BOREMASTER DATA ** PAPERS: V120166 ** ALT DATE: 01/11/83 **

COUNTY : GEORG MAP : 1:31680 N SURFACE RL: YIELD: 2.800 L/S SWL: 35.0 M S: EXP
PARISH : 44 ZONE : 08 (2) EQUIP: AIRLIFT DDL:
PORTION: 98 EAST : 253290 TOT DEPTH : 52.0 M DATE :30/07/1981 TOT DEPTH: 52.0 M T: EXP
R-BASIN: 421 NORTH: 828180 COMPLETED : 07-1981 TIME : HRS PUMP AT:

LIC:120166 NAME: THE AIA LAANECOORIE CO PERIOD: PP EXPIRY: PP/PP/PP LICAM1: LICAM2:

LOGS : DRILLER PROPOSED USE: STOCK & DOMESTIC CONTRACTOR: PRIVATE TYPE : BORE
MEAS : PRESENT USE : STOCK & DOMESTIC OWNER : PRIVATE METHOD: ROTARY AIR
SETTING: SALINITY : 501-1000 PPM DRILLER : DALT STATUS:

THICK	BASE		CGEW	DESCRIPTION	COLOUR	FORM
0.60	0.90	GRVL				
7.60	8.50	SHLE		AND GRVL		
21.9	30.40	SHLE	1			

CODE K2K9 DEPTH GIVEN 30.40 METRES

****
*** BORE NO: 50473 (57C4) ***
****

BOREMASTER DATA ** PAPERS: V117981 ** ALT DATE: 01/11/85 **

COUNTY : GEORG MAP : 1:31680 N SURFACE RL: YIELD: 0.010 L/S SWL: 3.0 M S: EXP
PARISH : 40 ZONE : 08 (2) EQUIP: AIRLIFT DDL:
PORTION: 112 EAST : 253660 TOT DEPTH : 54.9 M DATE :17/12/1980 TOT DEPTH: 54.9 M T: EXP
R-BASIN: 421 NORTH: 817540 COMPLETED : 12-1980 TIME : HRS PUMP AT:

LIC:117981 NAME: CARTWRIGHT PERIOD: PP EXPIRY: PP/PP/PP LICAM1: LICAM2:

LOGS : DRILLER PROPOSED USE: STOCK & DOMESTIC CONTRACTOR: PRIVATE TYPE : BORE
MEAS : PRESENT USE : ABANDONED OWNER : PRIVATE METHOD: ROTARY AIR
SETTING: SALINITY : BAD DRILLER : JON1 STATUS:

	DIAM	TOP	LTH/THK	TYPE	DESCRIPTION/SALINITY	APTR/SIZE	SWL	YIELD	ALT DATE	SH NO
CASING:				WITHDRAWN						1 01
	165 MM		54.9 M	DIAM DRILLED						1 02
AQUIFER:		6.7 M	0.3 M	FRACTURED	BAD		3.0 M	0.010 L/S		1 01

** DRILLER'S LOG **

C = CONFIDENCE LEVEL G = GRAINSIZE E = 1 = WATER SUPPLY W = WEATHERING

THICK	BASE		CGEW	DESCRIPTION	COLOUR	FORM
0.30	0.30	TPSL	9			
2.70	3.00	CLAY				

B4

*** BORE NO: 50473 (57C4) *** CONTINUED

** DRILLER'S LOG ** CONTINUED

C = CONFIDENCE LEVEL G = GRAINSIZE E = 1 = WATER SUPPLY W = WEATHERING

THICK	BASE		CGEW	DESCRIPTION	COLOUR	FORM
51.9	54.90	SHLE			GREY	

CODE F6DD DEPTH GIVEN 54.90 METRES

****
*** BORE NO: 50627 (57C4) ***
****

BOREMASTER DATA ** PAPERS: V114706 ** ALT DATE: 12/06/81 **

YIELD: 0.300 L/S SWL: 18.2 M S: EXP

THICK BASE CGEW DESCRIPTION COLOUR FORM
0.30 0.30 TPSL 9
0.92 1.22 CLAY
2.13 3.35 BSLT DCMP
1.53 4.88 ROCK

CODE AMJN DEPTH GIVEN 4.88 METRES

****
*** BORE NO: 20972 (57C4) ***
****

BOREMASTER DATA ** PAPERS: 64/07017 ** ALT DATE: 09/05/79 **

COUNTY : GEORG MAP : GRATICULE SURFACE RL: YIELD: 1.819 L/S SWL: 4.3 M S: EXP
PARISH : 40 ZONE : EQUIP: DDL: 6.4 M
PORTION: 207 TOT DEPTH : 18.6 M DATE :19/05/1955 TOT DEPTH: 18.6 M T: EXP
R-BASIN: 421 COMPLETED : 04-1955 TIME : HRS PUMP AT:

LOGS : DRILLER PROPOSED USE: CONTRACTOR: PRIVATE TYPE : B OPEN THRU ROCK
MEAS : PRESENT USE : OWNER : PRIVATE METHOD: CABLE TOOL
SETTING: SALINITY : DRILLER : STATUS:

	DIAM	TOP	LTH/THK	TYPE	DESCRIPTION/SALINITY	APTR/SIZE	SWL	YIELD	ALT DATE SH NO
CASING:	127 MM	A 0.3 M	18.0 M	THREAD STEEL	SEATED				1 01
AQUIFER:		6.4 M	SOAK	FRACTURED				SEEP	1 01
		18.6 M		FRACTURED			4.3 M	1.819 L/S	1 02

NOTE: 0.9M OF GRAVEL IN BASE OF HOLE 1 09/05/79

I3

*** BORE NO: 20972 (57C4) *** CONTINUED

** DRILLER'S LOG **
****
C = CONFIDENCE LEVEL G = GRAINSIZE E = 1 = WATER SUPPLY W = WEATHERING
THICK BASE CGEW DESCRIPTION COLOUR FORM
13.4 13.41 SHLE 9 ORNG
5.18 18.59 PRPR

CODE AAER DEPTH GIVEN 18.59 METRES

****
*** BORE NO: 24365 (57C4) ***
****

BOREMASTER DATA ** PAPERS: 66/08885 ** ALT DATE: 09/05/79 **

COUNTY : WESTM MAP : GRATICULE SURFACE RL: YIELD: 0.354 L/S SWL: 2.4 M S: EXP
PARISH : 40 ZONE : EQUIP: DDL:
PORTION: 43 TOT DEPTH : 48.8 M DATE : 05/1966 TOT DEPTH: 48.8 M T: EXP
R-BASIN: 421 COMPLETED : 05-1966 TIME : HRS PUMP AT:

```
SH NO
1 01
1 01

** DRILLER'S LOG **
*******************
                     C = CONFIDENCE LEVEL  G = GRAINSIZE  E = 1 = WATER SUPPLY  W = WEATHERING
THICK     BASE       CGEW    DESCRIPTION        COLOUR        FORM
0.30       0.30 TPSL 9
21.0      21.30 CLAY           CLRD
15.2      36.50 SHLE    1
                               CODE  IAAN          DEPTH GIVEN   36.50 METRES
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**********************************
*** BORE NO:  48601  (  57C4)  ***
**********************************

BOREMASTER DATA        **  PAPERS: V108524   **  ALT DATE: 07/09/79  **
***************
COUNTY  : GEORG    MAP  :  GRATICULE    SURFACE RL:              YIELD:     0.151 L/S    SWL:    45.0 M    S:    EXP
PARISH  :    40    ZONE :                                        EQUIP:                  DDL:
PORTION:     21                         TOT DEPTH :      0.0 M   DATE :   08/1978  TOT DEPTH:    0.0 M    T:    EXP
R-BASIN:    421                         COMPLETED : 08-1978      TIME :          HRS PUMP AT:

LIC:108524  NAME: HOPE                  PERIOD: PP  EXPIRY: PP/PP/PP  LICAM1:              LICAM2:

LOGS    : DRILLER          PROPOSED USE:  GENERAL               CONTRACTOR:  PRIVATE     TYPE    :  BORE
MEAS    :                  PRESENT USE :  ABANDONED             OWNER      :  PRIVATE     METHOD:   ROTARY AIR
SETTING:                   SALINITY    :                        DRILLER    :  DALT        STATUS:
```

	DIAM	TOP	LTH/THK	TYPE	DESCRIPTION/SALINITY	APTR/SIZE	SWL	YIELD	ALT DATE	SH NO
CASING:		0.0 M	82.3 M	BACKFILLED						1 01
AQUIFER:		45.1 M	0.1 M	FRACTURED			45.0 M	0.151 L/S		1 01

```
SH NO
1 01

** DRILLER'S LOG **
*******************
                     C = CONFIDENCE LEVEL  G = GRAINSIZE  E = 1 = WATER SUPPLY  W = WEATHERING
THICK     BASE       CGEW    DESCRIPTION        COLOUR        FORM
0.30       0.30 TPSL 9
13.7      14.00 LOAM                            RED
21.0      35.00 SHLE          SOFT CLRD
16.8      51.80 SHLE    1     CLRD
                    1         SOME SOFT BNDS
30.5      82.31 SHLE          HARD
                               CODE  ACN4          DEPTH GIVEN   82.31 METRES
```

N3

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PRINT: 06/11/87                        WATER RESOURCES COMMISSION                PAGE:  26676
MAP NO:   57C4              BOREMASTER/LITHOLOGY PRINTOUT  -  PROGRAM: WCBL30     [illegible] 49162

SH NO
1 01
1 01

**********************************
*** BORE NO:  49162  (  57C4)  ***
**********************************

BOREMASTER DATA        **  PAPERS: V108701   **  ALT DATE: 17/03/80  **
***************
COUNTY  : WESTM    MAP  :  GRATICULE    SURFACE RL:              YIELD:                  SWL:     5.5 M    S:    EXP
PARISH  :    40    ZONE :                                        EQUIP:                  DDL:    19.3 M
PORTION:     21                         TOT DEPTH :     24.4 M   DATE :       1978  TOT DEPTH:   24.4 M    T:    EXP
R-BASIN:    421                         COMPLETED :    1978 [illegible]  TIME :      HRS PUMP AT:
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*** BORE NO: 51110 (57C4) *** CONTINUED

** DRILLER'S LOG ** CONTINUED

C = CONFIDENCE LEVEL G = GRAINSIZE E = 1 = WATER SUPPLY W = WEATHERING

THICK	BASE		CGEW	DESCRIPTION	COLOUR	FORM
17.0	37.00	SHLE	1			

CODE UUYH DEPTH GIVEN 37.00 METRES

*** BORE NO: 51595 (57C4) ***

BOREMASTER DATA ** PAPERS: V111808 ** ALT DATE: 30/06/82 **

COUNTY : GEORG
PARISH : 29
PORTION: 15
R-BASIN: 412

MAP : 1:31680 S
ZONE : 08 (2)
EAST : 259400
NORTH: 802840

SURFACE RL:
TOT DEPTH : 24.7 M
COMPLETED : 05-1980

YIELD: 0.630 L/S SWL: 5.5 M S: EXP
EQUIP: AIRLIFT DDL:
DATE :28/05/1980 TOT DEPTH: 24.7 M T: EXP
TIME : 1.5 HRS PUMP AT:

LIC:111808 NAME: STAPLETON PERIOD: PP EXPIRY: PP/PP/PP LICAM1: LICAM2:

LOGS : DRILLER
MEAS :
SETTING:

PROPOSED USE: STOCK
PRESENT USE : STOCK
SALINITY : GOOD

CONTRACTOR: PRIVATE
OWNER : PRIVATE
DRILLER : WMIN

TYPE : BORE
METHOD: ROTARY AIR
STATUS:

	DIAM	TOP	LTH/THK	TYPE	DESCRIPTION/SALINITY	APTR/SIZE	SWL	YIELD	ALT DATE	SH NO
CASING:	165 MM	A 0.3 M	24.7 M	WELDED STEEL	SEATED					1 01
AQUIFER:		21.3 M	3.1 M	UNCNSLIDATED	GOOD		5.5 M	0.630 L/S		1 01

** DRILLER'S LOG **

C = CONFIDENCE LEVEL G = GRAINSIZE E = 1 = WATER SUPPLY W = WEATHERING

THICK	BASE		CGEW	DESCRIPTION	COLOUR	FORM
0.30	0.30	TPSL	9			
1.50	1.80	CLAY			BLCK	
0.90	2.70	BSLT			BLCK	
0.60	3.30	CLAY				
11.3	14.60	METL	9		BLUE	
4.30	18.90	CLAY		AND GRVL	YLLW	
5.80	24.70	SAND	1	FINE	YLLW	

CODE KZDK DEPTH GIVEN 24.70 METRES

*** BORE NO: 52141 (57C4) ***

BOREMASTER DATA ** PAPERS: V112645 ** ALT DATE: 30/06/82 **

COUNTY : WESTM
PARISH : 40
PORTION: 72
R-BASIN: 421

MAP : 1:31680 N
ZONE : 08 (2)
EAST : 263750
NORTH: 823850

SURFACE RL:
TOT DEPTH : 45.7 M
COMPLETED : 04-1980

YIELD: 0.070 L/S SWL: S: EXP
EQUIP: DDL:
DATE :24/04/1980 TOT DEPTH: 45.7 M T: EXP
TIME : HRS PUMP AT:

LIC:112645 NAME: WESTMORLAND PASTORAL CO PERIOD: PP EXPIRY: PP/PP/PP LICAM1: LICAM2:

G4

D4

PRINT: 06/11/87 WATER RESOURCES COMMISSION PAGE: 26681

MAP NO: 57C4 BOREMASTER/LITHOLOGY PRINTOUT - PROGRAM: WCBL30 57C4 50906

****
*** BORE NO: 50906 (57C4) ***
****

BOREMASTER DATA ** PAPERS: V111774 ** ALT DATE: 12/06/81 **
****

COUNTY : GEORG MAP : GRATICULE SURFACE RL: YIELD: 6.310 L/S SWL: 8.2 M S: EXP
PARISH : 29 ZONE : EQUIP: AIRLIFT DDL:
PORTION: 45 TOT DEPTH : 30.5 M DATE :28/06/1980 TOT DEPTH: 30.5 M T: EXP
R-BASIN: 412 COMPLETED : 06-1980 TIME : HRS PUMP AT:

LIC:111774 NAME: TODLE PERIOD: PP EXPIRY: PP/PP/PP LICAM1: LICAM2:

LOGS : DRILLER PROPOSED USE: STOCK CONTRACTOR: PRIVATE TYPE : BORE
MEAS : PRESENT USE : STOCK OWNER : PRIVATE METHOD: ROTARY AIR
SETTING: SALINITY : GOOD DRILLER : JONE STATUS:

	DIAM	TOP	LTH/THK	TYPE	DESCRIPTION/SALINITY	APTR/SIZE	SWL	YIELD	ALT DATE SH NO
CASING:	165 MM	A 0.3 M	24.7 M	WELDED STEEL	DRVN SMALL HOLE				1 01
AQUIFER:		22.9 M	4.5 M	FRACTURED	GOOD		8.2 M	6.310 L/S	1 01
SCREEN:	165 MM	22.9 M	1.5 M	VERTCL SLOTS	SLOTTED OXY-ACET	2 00 MM			1 01

** DRILLER'S LOG **
****

C = CONFIDENCE LEVEL G = GRAINSIZE E = 1 = WATER SUPPLY W = WEATHERING

NO	THICK	BASE		CGEW	DESCRIPTION	COLOUR	FORM
01	0.30	0.30	LOAM	9			
02	1.50	1.80	CLAY			RED YLLW	
	5.50	7.30	SHLE				
	7.90	15.20	CLAY			GREN	
	9.20	24.40	SHLE	1			
	6.10	30.50	SCST	1			

CODE UZP9 DEPTH GIVEN 30.50 METRES

****
*** BORE NO: 51022 (57C4) ***
****

BOREMASTER DATA ** PAPERS: V115609 ** ALT DATE: 12/06/81 **
****

COUNTY : WESTM MAP : GRATICULE SURFACE RL: YIELD: 0.370 L/S SWL: 9.5 M S: EXP
PARISH : 40 ZONE : EQUIP: AIRLIFT DDL:
PORTION: 148 TOT DEPTH : 38.4 M DATE :22/08/1980 TOT DEPTH: 38.4 M T: EXP
R-BASIN: 421 COMPLETED : 08-1980 TIME : HRS PUMP AT:

LIC:115609 NAME: SACCHETTI PERIOD: PP EXPIRY: PP/PP/PP LICAM1: LICAM2:

LOGS : DRILLER PROPOSED USE: DOMESTIC CONTRACTOR: PRIVATE TYPE : B OPEN THRU ROCK

Using these assumptions and the pit plan the following inflow estimates are obtained

Year	Pit Inflow (m^3/day)
1	90
2	160
3	220
4	270

The inflow values are sensitive to the actual permeability and storativity in the aquifer and its limiting boundaries. With the present restricted data it must be realised that the inflow values estimated may vary by plus or minus 50%. In addition, the seepage face on the pit wall will be subject to evaporation.

In general, the estimated inflows are low and can be managed by in-pit sumps and pumps.

In-pit pumps will need to be able to handle water derived by high intensity storms. There are no sufficient records available at present on their occurrence and distribution. From the records collected at Buckburraga between 1982 and 1986, the highest daily precipitation has been 63 mm which occurred once during that period. Generally, less than ten days per year recorded rainfall equal or greater than 20 mm.

The drain equations used to calculate pit inflows can also be used to estimate the effective radius of influence on the water table of the mining activity. At the end of year 4 it is estimated that there will be no long term change on the water table beyond a distance of 1500 m from the pit wall; at this distance the average annual rainfall recharge will balance flow to the pit.

There are no groundwater users within a radius of 1.5 km of the mine and therefore there is no impact on existing users from the mine inflows.

8.0 HYDROCHEMISTRY

Water samples were collected by AGC from drillholes LXD140, LDD146, LDD154, LDD165 and LDD178.

The samples were analysed by SGS for standard ions and for a range of heavy metals.

The analytical results are summarised in Table 3 and included in full in Appendix III.

Holes LDD146, 154, 165 and 178 are within the proposed pit area. The analysis shows the water to be of low conductivity (660 umhos/cm maximum), and slightly acid.

Hole LDD140 is approximately 300 m south west of the proposed pit and is flowing. The conductivity of this water is 2100 umhos/cm. Hole LDD178 in Hackney's Creek downstream of the tailings area is also a flowing bore and has a conductivity of 1000 umhos/cm.

The holes sampled within the pit are generally of potable quality, with the exception of the Manganese content of bore LDD165, which at 1760 mg/L exceeds the desirable level of 500 ug/L.

Hole LDD140 and LDD178 are both of potable quality. They are at the least desirable extreme of total solids but do not exceed desirable levels in any particular constituent.

9.0 TAILINGS

9.1 Location

The tailings site is located in the upper reaches of Hackney Creek (Figure 1). The tributary that the empoundment will cover does not generally flow. However, 200 m downstream from the proposed tailings dam wall, Hackney Creek at the confluence with this tributary is reported to be perennial.

9.2 Hydrogeology

The site geology, as described by D.J. Douglas and Partners Pty. Ltd., is as follows:

> 'The site is covered by 0.1 - 0.6 m of slightly organic topsoil and silty sand. In all but one location (T6) this material overlies 0.45 - 1.0 m of red brown silty clay. This in turn overlies weathered sandstone of the Triangle Group. The sandstone is intruded by quartz veins and thin granite dykes.'

From aerial photography and site observations the tailings catchment is associated with a structural lineament which currently forms the main drainage path.

Groundwater levels beneath the site have been determined from drilling as summarised in Table 4. Intersections of visible groundwater during drilling were at variable depths greater than 13 m and in some cases insufficient water was encountered to be recorded. The water levels when measured 5 to 6 days after drilling were generally between 6 and 10 m below ground level. The groundwater contours calculated from these water levels are presented in Figure 1. The flow gradient is towards Hackney Creek. Projections suggest that groundwater flow passes under Hackney Creek at the confluence but may emerge further downstream.

Permeability testing has been carried out on test holes LDD202 and LDD201 by D.J. Douglas & Partners. The results are summarised in Table 2 of their report. The permeability testing on hole LDD202 included a section containing the clay layer with some quartz veining. A permeability of 2 x 10^{-7} m/sec was calculated. Permeability on recompacted samples, taken from test pits across the area was less than 10^{-9} m/sec. Based on these, D.J. Douglas & Partners estimated that the permeability of the in place clay layer was 10^{-8} m/sec to 10^{-9} m/sec. ?

remoulded.

The underlying weathered sandstone has variable permeability, ranging from unmeasurably low to 2.3 x 10^{-5} m/sec. The fresh sandstone below 17 m in LDD202 gave permeabilities of 2 x 10^{-5} to 7 x 10^{-7} m/sec.

The interpreted permeability of the site for the tailings dam is summarised as follows:

STRATA	THICKNESS (m)	COMMENTS, PERMEABILITY
Surficial soils	0.1 to 0.6	to be removed
Silty clay	0.45 to 1.0 (2.5 in LDD202)	10^{-8} to 10^{-9} m/sec (?)
Weathered sandstone	14 to 46 generally 20	5 x 10^{-7} m/sec
Fresh sandstone	unknown	7 x 10^{-6} m/sec generally with zones as high as 2 x 10^{-5} m/sec

The existing site groundwater conditions are shown in section in Figure 7.

9.3 Seepage Rates

The tailings empoundment proposed by Kinhill is a staged structure as shown in Figure 7. Stage 1 is planned for years 0 to 1.5, Stage 2 for 1.5 to 2.5 years and Stage 3 to end of year 5.

Kinhill estimate that the tailings slurry distributed to the empoundment should contain 450 000 m^3/annum of water, of this 250 000 m^3/annum should be reclaimed through the decant facilities. On an annual basis rainfall contribution and evaporation losses are anticipated to approximately balance each other with evaporation more likely to dominate. The remaining water, 200 000 m^3/annum, will either be retained within the tailings as residual moisture or will infiltrate from the tailings pond area. The retained moisture for drained tailings is estimated at 50 000 m^3/annum leaving 150 000 m^3 of drainable water (410 m^3/day).

The permeability of the majority of tailings has been estimated at 5×10^{-8} m/sec by Douglas & Partners. Maximum seepage available from tailings based on a permeability of 5×10^{-8} m/sec and a unit gradient through the tailings (ie. totally saturated tailings) is as follows:

End of Stage	Year	Seepage (m^3/day)
1.	1.5	300
2.	2.5	430
3.	5	640

These rates will be upper bounds due to the assumption that the total surface area of tailings is saturated. In particular the seepage estimate is high for Stage 3 when the decant pond should not be significantly larger than during Stage 1 or Stage 2, and a large proportion of tailings material should be unsaturated.

A more detailed seepage analysis has been carried out by AGC employing techniques given by Vick (1983), Bower (1978) and McWhorter and Nelson (1979) and assuming no preferential flow path in the foundations. Two cases of permeability for the underlying clay layer have been considered, Case 1 with 10^{-8} m/sec and Case 2 with 10^{-9} m/sec. For each case the sensitivity of the deeper aquifer permeability has been assessed by carrying out analysis with permeabilities of 10^{-6} and 10^{-5} m/sec.

Following the commencement of the placement of tailings, three phases in seepage flow occur.

Phase 1: A wetting front moves vertically downward through the clay layer and the remaining unsaturated sequence towards the water table.

Phase 2: A rising groundwater mound forms on the existing water table and approaches the base of the tailings.

Phase 3: The groundwater mound reaches the base of the tailings empoundment and results in a saturated hydraulic connection between the tailings deposit and groundwater storage.

Analysis of conditions where the underlying clay layer permeability was taken as 10^{-8} m/sec (Case 1) indicated that initially the clay layer was capable of passing in excess of the available seepage from the tailings. The available seepage is 410 m^3/day, which could drain from an area of 41 000 m^2 under a head of 8.5 m. However, at the end of Stage 2 there is an area of 70 000 m^2 and an available head of about 10 m. Therefore, the actual rate of seepage initially would be governed by the seepage available from the draining tailings.

An analysis of the underlying mounding based on an initial seepage of 300 m^3/day, a clay layer at 10^{-8} m/sec and an underlying aquifer at 10^{-6} m/sec gives the following:

Period (days)	Affect
0-100	Tailings build up, saturation commences through clay. (Seepage rate 300 m^3/day)
100-180	Unsaturated flow below clay. 80 day travel time of seepage front to water table.
180-200	Mounding on water table starts and eventually reaches top of weathered sandstone.
200+	Saturated flow conditions throughout vertical section; , seepage decreases to 25 m^3/day.

The decrease in seepage to 25 m^3/day during Phase 3 is due to the control on seepage changing from vertical to lateral spreading. The resistance to lateral spreading during Phase 3 causes the pore water pressure to increase on the interface between the empoundment and the foundation material, reducing the vertical gradients in the tailings and underlying clay layer and, therefore, the seepage rates.

Analyses based on alternative permeabilities for the clay and underlying aquifer were carried out. The results are summarised as follows:

	Case 1 (Clay = 10^{-8} m/sec)		Case 2 (Clay = 10^{-9} m/sec)	
	a) aquifer = 10^{-6}m/s	b) aquifer = 10^{-5}m/s	a) aquifer = 10^{-6}m/s	b) aquifer = 10^{-5}m/s
initial seepage rate m^3/d	300	300	65	65
days to reach water table	180	180	420	420
seepage at saturation rate m^3/d	25	75	<25	<50
days to attain saturated flow	200	220	600	>5500

In Case 2 the seepage rate is initially governed by the clay layer rather than the tailings as in Case 1.

Note also that for Case 2, if the underlying aquifer has a permeability of 10^{-5} m/sec rather than 10^{-6} m/sec the mounding would occur over a period of greater than 15 years and, therefore saturated conditions would not occur during the life of the empoundment (5 years). Hence, in this case, on completion of empoundment the tailings seepage would continue at a rate of 65 m^3/day until the tailings have drained.

9.4 Seepage Travel Times

The aquifer underlying the tailings empoundment has a natural gradient of approximately 4.5%. Assuming an average permeability of 10^{-6} m/sec, a 10 m thickness and 400 m width a natural through-flow of 15 m^3/day is possible. Similarly an aquifer permeability of 10^{-5} m/sec would give 150 m^3/day throughflow.

The travel velocity of the seepage within the aquifer following the arrival of the wetting front could be approximately the natural throughflow velocity. This would be an average 5 m/year, based on specific yield of 0.3 and permeability of 10^{-6} m/sec, or 50 m/year based on a permeability of 10^{-5} m/sec. It should be noted that these are average values and do not preclude localised preferred flow paths where some seepage mixed with existing groundwater may travel faster than this.

Following the formation of saturated conditions through mounding an increased velocity could eventuate due to increased head. Using the seepage quantities estimated, the above velocities could be approximately doubled.

In summary, based on average permeabilities the seepage from the tailings area could be transported to Hackneys Creek downstream of the dam within 18 months for Case 1 and within 2.3 years for Case 2. This assumes the higher permeability (10^{-5} m/sec) for the underlying aquifer. If the permeability is 10^{-6} m/sec the travel times would be in the order of 10 to 20 years.

9.5 Seepage Impact and Cyanide Degradation

The tailings dam location in the upper reaches of a perennial creek, and the proximity of the empoundment to this creek, will attract close scrutiny from regulatory authorities. The mechanisms of seepage movement from the empoundment will be a function of a number of interrelated factors, viz:

Management of storage (water balance, placement of tailings)
Nature of tailings (grind, slimes, geochemical properties)
Permeability and moisture content of underlying material.

The movement of particular constituents within the seepage will be further affected by attenuation, dispersion and dilution. The constituents of the tailings liquor estimated by Minproc Engineers Pty. Ltd. are as follows:

Cyanide,	100 - 200 ppm (max 300)
pH,	10 to 10.5
Heavy Metals,	minimal
Residual gold,	<0.05 ppm
Cyanide Complexes,	dependent on sulphide content of ore (reported to be minimal).

BURRAGA 146

TIME (seconds)	WATER LEVEL (meters)	DRAWDOWN (meters)	H/H0
240	15.73	4.58	.1484603
300	15.7	4.55	.1474878
360	15.66	4.51	.1461913
420	15.59	4.44	.1439222
480	15.52	4.37	.1416532
540	15.4	4.25	.1377634
600	15.34	4.19	.1358185
900	14.6	3.45	.1118315
1200	14.59	3.44	.1115073
1500	14.21	3.06	9.918964E-02
1800	13.85	2.70	8.752029E-02
2100	13.6	2.45	7.941656E-02
2700	13.1	1.95	.0632091
3000	12.8	1.65	5.348462E-02

UNCONFINED AQUIFER

K = 0.6E-05 cm/sec
= 0.1 gpd/ft2
= 0.2E-06 ft/sec
= 0.0 ft/day

REGRESSION COEFFICIENT = -.9962083

BURRAGA148

TIME (seconds)	WATER LEVEL (meters)	DRAWDOWN (meters)	H/H0
60	29	15.40	.6311476
90	28.27	14.67	.6012296
120	27.53	13.93	.5709016
150	27	13.40	.5491803
180	26.55	12.95	.5307376
240	25.45	11.85	.4856558
300	24.35	10.75	.4405738
360	23.32	9.72	.3983606
420	22.53	8.93	.3659836
480	21.68	8.08	.3311476
540	21.18	7.58	.3106557
600	20.61	7.01	.2872951
900	19.12	5.52	.2262295
1200	17.73	4.13	.1692623
1500	16.9	3.30	.1352459
1800	16.27	2.67	.1094262
2100	15.8	2.20	9.016393E-02
2400	15.41	1.81	7.418031E-02
2700	15.11	1.51	6.188522E-02
3000	14.95	1.35	5.532785E-02

UNCONFINED AQUIFER

K = 0.4E-04 cm/sec
= 0.8 gpd/ft2
= 0.1E-05 ft/sec
= 0.1 ft/day

REGRESSION COEFFICIENT = -.9880937

BURRAGA150

TIME (seconds)	WATER LEVEL (meters)	DRAWDOWN (meters)	H/H0
60	31.21	20.87	.5541689
90	30.58	20.24	.5374402
120	30.28	19.94	.5294743
150	29.84	19.50	.5177907
180	29.45	19.11	.507435
240	28.64	18.30	.4859267
300	27.86	17.52	.4652151
360	27.08	16.74	.4445035
420	26.44	16.10	.4275093
480	25.8	15.46	.4105151
540	25.21	14.87	.3948486
600	24.65	14.31	.3799788
900	22.75	12.41	.3295274
1200	21.04	10.70	.2841211
1500	19.19	8.85	.2349974
1800	17.69	7.35	.1951673
2100	16.44	6.10	.1619756
2700	15.33	4.99	.1325013
3000	14.19	3.85	.1022305

UNCONFINED AQUIFER

K = 0.5E-05 cm/sec
= 0.1 gpd/ft2
= 0.2E-06 ft/sec
= 0.0 ft/day

REGRESSION COEFFICIENT = -.9980698

BURRAGA154

TIME (seconds)	WATER LEVEL (meters)	DRAWDOWN (meters)	H/H0
60	52.56	32.13	.8119788
90	52.14	31.71	.8013647
120	51.85	31.42	.7940359
150	51.42	30.99	.783169
180	51	30.57	.772555
240	50.12	29.69	.7503159
300	49.16	28.73	.7260551
360	48.27	27.84	.7035633
420	47.33	26.90	.679808
480	46.61	26.18	.6616123
540	45.81	25.38	.641395
600	45.06	24.63	.6224413
900	41.51	21.08	.5327268
1200	39.28	18.85	.476371
1500	37	16.57	.4187516
1800	35.71	15.28	.3861511
2100	34.66	14.23	.3596159
2400	33.45	13.02	.3290372
2700	32.28	11.85	.2994693

UNCONFINED AQUIFER

K = 0.4E-05 cm/sec
= 0.1 gpd/ft2
= 0.1E-06 ft/sec
= 0.0 ft/day

REGRESSION COEFFICIENT = -.9936931

BURRAGA175

TIME (seconds)	WATER LEVEL (meters)	DRAWDOWN (meters)	H/H0
60	15.61	14.61	.3563415
90	15.05	14.05	.3426829
120	14.66	13.66	.3331707
150	14.3	13.30	.3243903
180	14.03	13.03	.3178049
240	13.34	12.34	.3009756
300	12.67	11.67	.2846341
360	12.09	11.09	.2704878
420	11.44	10.44	.2546341
480	11.01	10.01	.2441463
540	10.16	9.16	.2234146
600	9.58	8.58	.2092683
900	6.42	5.42	.1321951
1500	4.24	3.24	7.902438E-02
1800	3.55	2.55	6.219512E-02
2100	3.06	2.06	.0502439
2400	2.8	1.80	4.390244E-02
2700	2.61	1.61	3.926829E-02
3000	2.3	1.30	3.170732E-02

UNCONFINED AQUIFER

K = 0.3E-04 cm/sec
= 0.5 gpd/ft2
= 0.8E-06 ft/sec
= 0.1 ft/day

REGRESSION COEFFICIENT = -.992245

APPENDIX III

HYDROGEOCHEMICAL RESULTS

AUSTRALIAN GROUNDWATER CONSULTANTS PTY LTD

NATA

SGS SGS Australia Pty Ltd

Sydney

74 McEvoy Street,
Alexandria, N.S.W. 2015
P.O. Box 163, Redfern 2016
Tel 699 7625
Telex: AA22395
Cables: Supervise

R. W. CORKERY

ALSO COPY TO: Dr Fabio Carosone
Aust. Groundwater Consultants
Suite 16, 273 Alfred St Nth Sydney 2060

REPORT NO: ES 1336 CLIENT REF. NO: WHM:seb: 1987

DATE SAMPLES IN: 22.1.88 DATE REPORT OUT: 5.2.88

WATER ANALYSIS REPORT

The tests contained in this report have been carried out in accordance with the APHA standard methods 16th Edition, or other NATA approved methods listed below:

402	Acidity
403	Alkalinity
403	Bicarbonate
507/421F	Biochemical Oxygen Demand
406B	Carbon Dioxide (Free)
403	Carbonate
508A	Chemical Oxygen Demand
407A	Chloride
205	Conductivity
412B/C	Cyanide
421F	Dissolved Oxygen
315B	Ferrous/Ferric Iron
209B	Filterable Residue
413B	Fluoride
314A/B	Hardness Total
417E	Nitrogen - Ammonia
418D	Nitrogen - Nitrate
419	Nitrogen - Nitrite
420A	Nitrogen - Total
209D	Non-Filterable Residue
503A	Oil and Grease
424F	Orthophosphate
423	pH
424C/F	Phosphorus Total
425A	Silica
426A	Sulphate
214A	Turbidity
AAS	Fe, Mn, Na, K, Ca, Mg

SGS Australia Pty. Ltd.

REPORT No: ES 1336

SOURCE OF WATER						
SAMPLE No.	140		146		154	
DATE OF COLLECTION						
Conductivity (25°C µ mhos cm^{-1})	2100		530		660	
Total Filterable Residue (mg/L @ 180°C)						
Total Hardness (EDTA) as mg/L $CaCO_3$						
Calculated Hardness as mg/L $CaCO_3$						
pH	6.8		6.4		6.5	
	mg/L	mEq/L	mg/L	mEq/L	mg/L	mEq/L
Sodium Na^+	130	5.655	28	1.218	32	1.392
Potassium K^+	6.0	0.153	4.6	0.118	7.3	0.187
Calcium Ca^{++}	55	2.745	8.9	0.444	14	0.699
Magnesium Mg^{++}	174	14.313	47	3.866	63	5.182
		22.866		5.646		7.460
Chloride Cl^-	435	12.271	35	0.987	45	1.269
Carbonate $CO_3^=$	—		—		—	
Bicarbonate HCO_3^-	530	8.687	240	3.934	335	5.491
Sulphate $SO_4^=$	45	0.937	25	0.521	13	0.271
Nitrate NO_3^-	—		—		—	
Fluoride F^-	—		—		—	
		22.490		5.442		7.031
Total Iron Fe						
Silica SiO_2						
Total Alkalinity	430		200		275	
Non Filterable Residue	4		80		325	

SGS Australia Pty. Ltd.

REPORT No: ES 1336

SOURCE OF WATER						
SAMPLE No.	165		178			
DATE OF COLLECTION						
Conductivity (25°C μ mhos cm⁻¹)	340		1000			
Total Filterable Residue (mg/L @ 180°C)						
Total Hardness (EDTA) as mg/L $CaCO_3$						
Calculated Hardness as mg/L $CaCO_3$						
pH	5.9		6.4			
	mg/L	mEq/L	mg/L	mEq/L	mg/L	mEq/L
Sodium Na^+	26	1.131	115	5.003		
Potassium K^+	2.8	0.072	6.1	0.156		
Calcium Ca^{++}	4.1	0.205	53	2.645		
Magnesium Mg^{++}	19	1.563	55	4.524		
		2.971		12.328		
Chloride Cl^-	60	1.693	55	1.552		
Carbonate $CO_3^=$						
Bicarbonate HCO_3^-	80	1.311	690	11.309		
Sulphate $SO_4^=$	10	0.208	15	0.312		
Nitrate NO_3^-						
Fluoride F^-						
		3.212		13.173		
Total Iron Fe						
Silica SiO_2						
Total Alkalinity	65		565			
Non-Filterable Residue	20		95			

SGS Australia Pty Ltd

NEW SOUTH WALES
74 McEvoy St., Alexandria, Sydney, N.S.W. 2015
Tel: 699 7625 Tlx: SGSSYD AA122395 Fax: 698 3596

WESTERN AUSTRALIA
80 Railway Parade, Queens Park
Tel: 458 9668 Tlx: SGSPTH AA92624 Fax: 458 9361

7x8

Our ref ES 1336

Your ref WHM:seb:1987

Date received 22.1.88

Date completed 5.2.88

Issued at SYD WET LAB

ANALYTICAL REPORT

Sample Ref.	As	Cu	Pb	Zn	Mn	Cd	Fe	Bi
	←		µg/L			→	mg/L	µg/L
FILTERED ACIDIFIED								
2	<0.5	2.5	10	7.5	15	1.2	0.04	<0.5
3	↓	2.5	5.5	8.0	120	0.45	2.00	↓
4		1.0	4.0	4.5	9.0	0.60	0.54	
5		3.0	6.5	3.5	9.0	0.35	0.42	
7		1.0	5.0	4.0	4.5	0.25	0.32	
8		2.5	9.0	4.0	3.5	0.60	0.11	
9		3.5	5.0	6.5	4.0	0.50	0.70	
10		3.0	6.5	6.5	3.5	0.60	0.22	
11	↓	7.5	10	26	430	0.95	0.10	↓
140	4.5	5.5	10	7.5	22	1.0	<0.01	<0.05
146	0.5	64	52	92	265	0.50	0.14	↓
154	0.5	29	30	125	465	0.65	0.10	
165	<0.5	14	19	31	1760	0.35	0.12	
178	<0.5	5.0	9.5	20	17	0.65	0.05	↓

SGS

SGS Australia Pty Ltd

NEW SOUTH WALES
74 McEvoy St., Alexandria, Sydney, N.S.W. 2015
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WESTERN AUSTRALIA
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8x8

Our ref: ES 1336
Your ref: WHM: seb: 1987
Date received: 22.1.88
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Issued at: SYD WET LAB

ANALYTICAL REPORT

	Sample Ref.	As	Cu	Pb	Zn	Mn	Cd	Fe	Bi
		←		µg/L			→	mg/L	µg/L
2	NON-FILTERED ACIDIFIED								
3	2	<0.5	6.0	20	19	1780	1.5	0.91	<0.5
4	3	↓	5.5	6.0	15	980	0.60	11.1	↓
5	4		1.5	6.5	6.5	107	0.80	1.43	
6	5		4.5	5.0	8.0	110	0.55	1.29	
7	7		2.0	7.5	5.5	67	0.40	0.86	
8	8		4.0	11	9.0	17	0.75	0.42	
9	9		45	7.5	12	173	1.10	2.70	
10	10		5.0	10	115	40	0.85	0.60	
11	11		155	75	115	2400	1.3	5.6	
12	140	6.0	8.0	15	10	31	1.3	0.02	<0.5
13	146	2.0	112	170	165	940	0.75	1.31	↓
14	154	2.0	59	66	160	1410	0.85	0.98	
15	165	<0.5	41	36	77	2140	0.55	0.38	
16	178	<0.5	6.0	11	82	56	1.2	0.04	
17									
18									
19									
20									

RENISON GOLDFIELDS
CONSOLIDATED LTD.

LUCKY DRAW GOLD PROJECT

TAILINGS DAM AREA
PERMEABILITY TESTING

REPORT 3044/1
APRIL 1988

AUSTRALIAN
GROUNDWATER
CONSULTANTS
PTY LIMITED

AUSTRALIAN GROUNDWATER CONSULTANTS PTY LIMITED
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26 April 1988

Attention: Mr. N. Humphrey

Dear Sir

LUCKY DRAW GOLD PROJECT, BURRAGA NSW

We are pleased to forward herewith two copies of our report on permeability testing at the proposed tailings dam site. One copy has also been despatched to Bob McLoughlin.

Yours faithfully
AUSTRALIAN GROUNDWATER CONSULTANTS PTY LIMITED

W.H. Morton

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RENISON GOLDFIELDS CONSOLIDATED LTD

LUCKY DRAW GOLD PROJECT
TAILINGS DAM AREA
PERMEABILITY TESTING

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TAILINGS DAM AREA
PERMEABILITY TESTING

1.0 INTRODUCTION

The work carried out in the March '88 field program was aimed at improving the quality of permeability data of the ground in and around the tailings dam area and the knowledge of the permeability areal distribution.

The program consisted of:

1. Shallow air rotary and percussion drilling along the Oberon road to define the physical and hydraulic characteristics of the granite as a barrier.

2. Constant head permeameter tests on the surficial material between 0.5 and 1 m in depth.

3. Time-lag tests on selected RC bores.

4. Falling head tests on bores above water table.

5. Bulk transmissivity testing on a 29 m deep bore, downstream of the tailings dam, drilled for the purpose.

2.0 GRANITE BARRIER DEFINITION

Six holes to variable depths were drilled over a 550 m tract of the road to Oberon, covering the southeastern area of the tailings dam area. The aim of the drilling program was to achieve an accurate delineation of the granite sub-crop, in order to evaluate the effectiveness of that rock as a hydraulic barrier to the escape of leachates from the dumped tailings.

Weathered to fresh granite was intersected near the surface in 4 of the 6 bores drilled. Bores G4 and G5, straddling the axis of the valley to be blocked by the tailings dam, did not intersect granite but a sequence of fine sandstones and siltstones. The two bores were drilled to 12.5 and 19 m respectively. The two bores intersected the water table and, because the rig was not set up for drilling in wet conditions, drilling was halted.

The geological logs of these bores are appended. It appears that a substantial geological structural dislocation is present to the west of bore G4 and has its surface expression in the valley where the tailings are to be stored.

Figure 1 shows updated water table contours in the area, with levels in G4 and G5 estimated during drilling as the hole were backfilled. Figure 2 shows a section across the valley centreline and includes the maximum freeboard of the tailings liquor during the three stages of construction. The section indicates that the highest level of liquor during Stage 1 and 2 will be below or at a similar level than the water table at the head of the valley. Therefore, during these stages, no risk of contaminants flowing over into the next catchment exists.

During Stage 3 of filling, the liquor level will be higher than the water table divide by as much as 3.5 - 4 m. This level difference will be maintained for some time after completion of operations. During this stage, a risk of contaminants overspill exists. The rate of this flow will depend ultimately upon the difference in head between liquor and groundwater and upon the final permeability achieved for the liner.

3.0 PERMEABILITY TESTING

3.1 Constant Head Permeameter Tests

A series of ten, 1 m deep shallow holes were drilled at the dam site and on the floor of the valley behind the dam to evaluate the distribution of permeability of the surficial material.

A permeameter was used for the purpose. The technique consists in filling the hole with water to a determined level and then maintaining that level constant whilst accurately measuring the volumes of water required to do so. The permeability values obtained in these tests are summarised in Table 1 and range from 10^{-6} to 10^{-10} m/sec (10^{-2} to 10^{-6} m/day) with values mostly in the range of 10^{-7} m/sec. The lowest values of permeability were registered in the tailing dam area and in the central line of the valley.

3.2 Time-Lag Tests

Time-lag tests were carried out on some of the RC holes drilled by RGC in the tailings dam area. Such tests consist in quickly removing a known volume of water from a bore and in measuring the rate of recovery of the water level. These tests are, therefore, only possible in bores drilled below the water table and having low permeability.

Three successful tests were achieved although eight tests were attempted altogether. The successful tests were on bores RC 221, 225 and 227; the unsuccessful tests were on bores RC 223, 224, 228, 229 and 230. Of these, RC 228, 229 and 230 had either collapsed or were nearly dry. RC 223 and 224 failed because the aquifer at those sites is highly permeable and the rate of recovery of the water level was too fast to allow a sufficient number of measurements. RC 223 and 224 airlifted approximately 2 L/sec and 3.5 L/sec of clear water respectively which suggests a local core of very high permeability. It is strongly recommended that prior to the commencement of works, all the RC bores included in the impoundment area be properly grouted under supervision as they represent a possible avenue of fast contaminant movement.

Permeability values in the RC bores other than RC 223 and 224 are in the range 1×10^{-5} to 9×10^{-6} m/sec (8.6×10^{-1} and 7.8×10^{-1} m/day) which represent a moderate permeability. It appears that below a surficial horizon of low permeability, the siltstone and sandstone display an increased permeability, almost certainly due to joints and fractures.

3.3 Falling Head Tests

0Falling head tests were performed on bores P11 and G6 that were too deep to allow the use of the permeameter, but were still above water table. A measured volume of water was introduced in the hole and the rate of decline of the water level monitored. Bore G6 tested a 10 m thick sequence of weathered granite and bore P11 a sequence of 4 m of clays.

Low values of permeability were registered in these holes, in the range 10^{-7} and 10^{-8} m/sec (5×10^{-2} and 5.6×10^{-3} m/day).

3.4 Bulk Transmissivity Testing

In order to evaluate the aquifer transmissivity downstream of the tailings dam, a 29.5 m deep hole, L1, was drilled at 114 mm diameter and tested open hole.

The initial plan was to pump by airlift the well for at least an hour, monitor the flow and then measure the water level recovery. The airlifted yield was 0.6 L/sec. However, difficulties were experienced in measuring water levels in the conduit installed for the purpose and even in the open hole. After two tests were attempted, it was decided to carry out a time-lag test. The resulting permeability value obtained in this manner was 9×10^{-6} m/sec (7.8×10^{-1} m/day).

4.0 DISCUSSION

The results of the permeability tests are summarised in Table 1 and are also presented in Figures 3 and 4. The latter illustrate graphically the areal distribution of permeability in the tailings dam and storage area.

Figure 3 shows the permeability of the surficial material above water table and it shows that it is lowest along the central line of the valley with values in the range of 10^{-9} m/sec for bores P3, P5 and P6 and values in the range 10^{-8} m/sec for P2, P4 and P11. Around this area and up the slopes of the valley, the permeability increases to values of 10^{-7} m/sec or greater. No tests of surficial material were carried out on the southwestern side of the valley, due to access problems. The terrain on this side is of similar nature and, therefore, similar permeability values are expected.

The implications of these results is that the central portion of the tailings pondage area does not require re-working to achieve the desired level of permeability (10^{-9} m/sec), whereas this is necessary elsewhere.

In view of the costs of re-working the clay blanket, it may be economically advantageous to carry out a closely spaced grid of constant head permeameter tests to further refine the knowledge of the areal distribution of permeability.

Figure 4 is similar to Figure 3 but shows the distribution of permeability of the material (siltstone/sandstone) below water table. Values plotted in this plan include also values from Table 2, that reproduces Table 2 of D.J. Douglas and Partners Pty. Ltd., December 1987 report.

The values of permeability of the siltstone/sandstone aquifer are some order of magnitude larger than the surficial material. More importantly, they show that random higher values of permeability are associated with zone of fracturing. A possible zone of high permeability appears to be present through bores RC 223 and 224, that airlifted substantial volumes of water (2-3.5 L/sec) from fracture zones within the aquifer. These zones were postulated because of the presence of broken rock coated with weathering products brought up by the airlift. A line through these two bores would pass south of bore G4, where granite was not intersected. Possible fracture zones in bore BH 202, tested by D.J. Douglas and Partners, are likely in the intervals 12-15 m and 18 - 21 m.

The implication of the vertical increase in permeability is that any leachates that would escape the lining of the dam and pondage area, would reach water table and then travel down gradient to join the local groundwater regime.

The presence of these fracture zones whilst providing paths for preferred seepage movement also allow locations for effective interception bores if required.

These conditions and the new available data complicate manual calculations of seepage rates and of contaminant travel times a great deal. Although the numbers on average are not vastly different from those used in the initial calculations, the opportunity now exists for refinement by computer modelling of the conditions present under the tailings storage dam and area. Such a model will also allow the sensitivity of the system to variations in parameters to be evaluated.

Geochemical testing of the tailings and insitu soils is currently being carried out to assess the attenuation of contaminants moving towards the groundwater. Preliminary results from this testing should be reviewed prior to commencing numerical modelling to assess whether the hydraulics or the geochemistry will govern the migration of contaminants. Sufficient chemical analyses should be available by 4 May to make this assessment.

Numerical modelling of the present groundwater regime prior to the beginning of operations, during the various stages of tailings pond filling and subsequent rehabilitation phase would analyse:

a) The seepage rates and movement rates from the pondage area.

b) The effect of the freeboard of the tailings liquor above the groundwater divide during stage 3 of the operations.

c) The effectiveness of a cut-off wall to restrict or impede contaminant movement, as this option has been considered among the engineering solutions.

d) The effectivenes of a collection interception system downstream of the tailings dam.

In addition, numerical modelling will provide input to the design of the above elements should they become necessary.

Finally, should the EIS results be contested, the numerical modelling will provide a base to argue against the objections raised.

5.0 CONCLUSIONS AND RECOMMENDATIONS

The results of the field work carried out have indicated that a large variation in permeability values exists both areally and vertically around the proposed tailings storage area. On present data, it is recommended that a portion of the valley floor bounded by bores P2, P3, P4, P5 and P6 does not require re-working, but that such work is necessary elsewhere in the impoundment zone.

Dependent on results from geochemical testing currently underway it may be necessary that computer modelling of the variable unsaturated-saturated flow regime be carried out, using the now available data. Advantages in the analysis and in the design of the tailings dam and pondage can be derived from such a study.

TABLE 1

SUMMARY OF PERMEABILITY TESTS

HOLE	DEPTH T.D. m	INTERVAL TESTED m	K m/sec
P1	0.8	0.3 - 0.8	1.4 x 10-7
P2	0.9	0.4 - 0.9	3.5×10^{-8}
P3	0.9	0.4 - 0.9	2.9×10^{-9}
P4	0.9	0.35 - 0.9	1.7×10^{-8}
P5	1.0	0.5 - 1.0	9.8×10^{-10}
P6	1.0	0.5 - 1.0	9.8×10^{-10}
P7	0.93	0.35 - 0.93	1.2×10^{-6}
P8	1.0	0.5 - 1.0	8.1×10^{-7}
P9	0.9	0.4 - 0.9	1.4×10^{-7}
P10	0.96	0.46 - 0.96	2.0×10^{-7}
P11	4.9	0.85 - 4.9	8.4×10^{-8} (10-30 min)
			3.9×10^{-8} (30-126 min)
G6	12.3	2 - 12.3	5.4×10^{-7}
L1	29.5	5.1 - 28.3	9×10^{-6}
221	41.0	6.3 - 29.4	1×10^{-5}
225	21.0	8.97 - 16.5	4×10^{-6}
227	45.0	13.06 - 29.2	4×10^{-6}

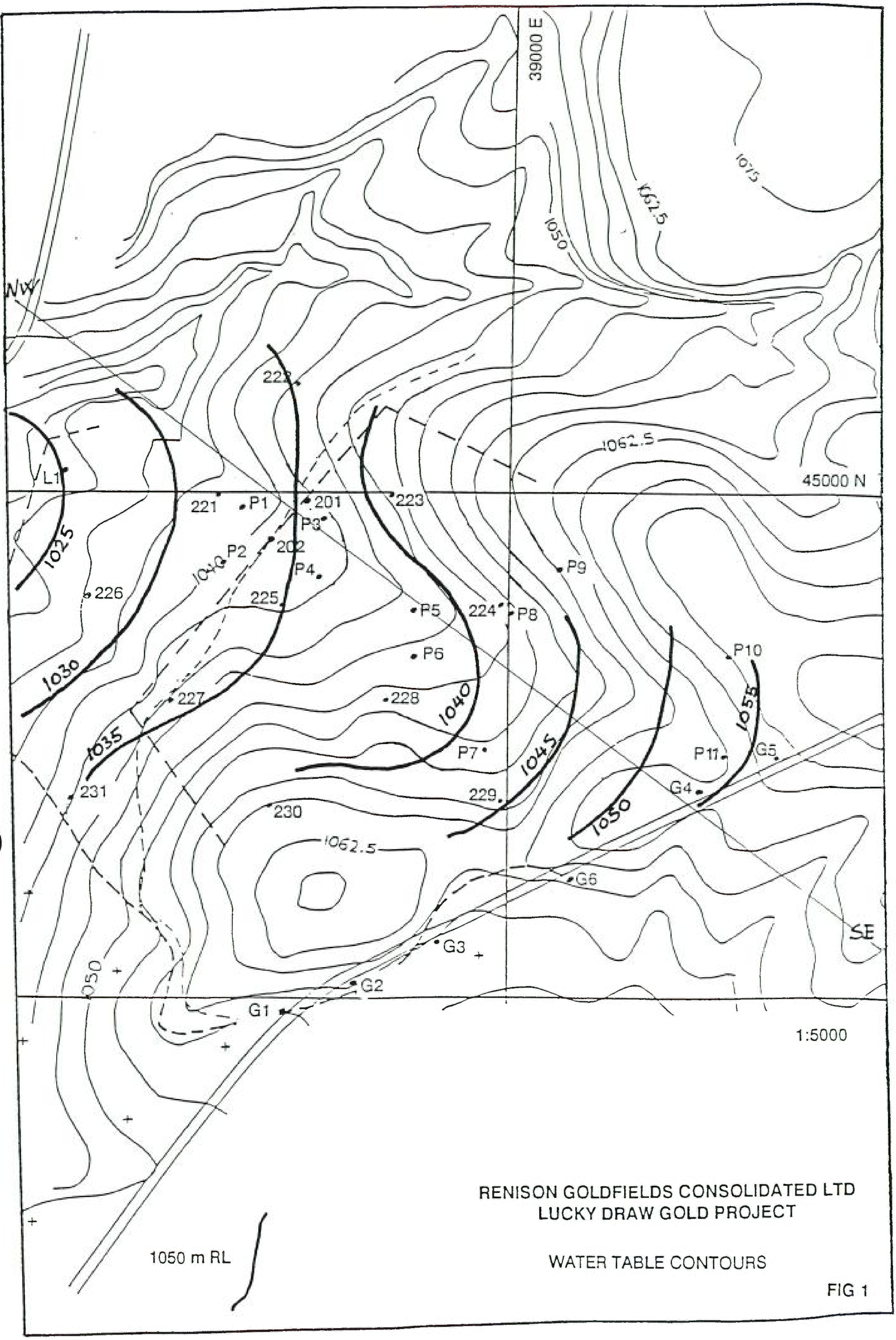
TABLE 2

SUMMARY OF PERMEABILITY VALUES

(from D.J. Douglas and Partners Pty. Ltd., December 1987)

HOLE	DEPTH m	INTERVAL TESTED m	K* m/sec
BH 201	6.52	1.03 - 1.24	2.3 x 10-7
		1.33 - 2.82	9.2×10^{-7}
		2.80 - 5.91	3.7×10^{-7}
		5.91 - 6.52	2.4×10^{-6}
BH 202	32.97	1.90 - 3.24	3.4×10^{-7}
		2.32 - 5.74	2.0×10^{-7}
		5.95 - 9.05	4.5×10^{-6}
		9.05 - 12.22	$< 10^{-7}$
		12.34 - 15.41	2.3×10^{-5}
		15.41 - 18.17	$< 10^{-7}$
		18.17 - 21.19	2.1×10^{-5}
		21.19 - 24.23	6.6×10^{-7}
		24.23 - 27.28	1.4×10^{-6}
		27.28 - 30.27	7.0×10^{-6}
		30.27 - 32.97	1.1×10^{-6}

* original values given in Lugeons, converted to m/sec by multiplying by 1.1×10^{-7}



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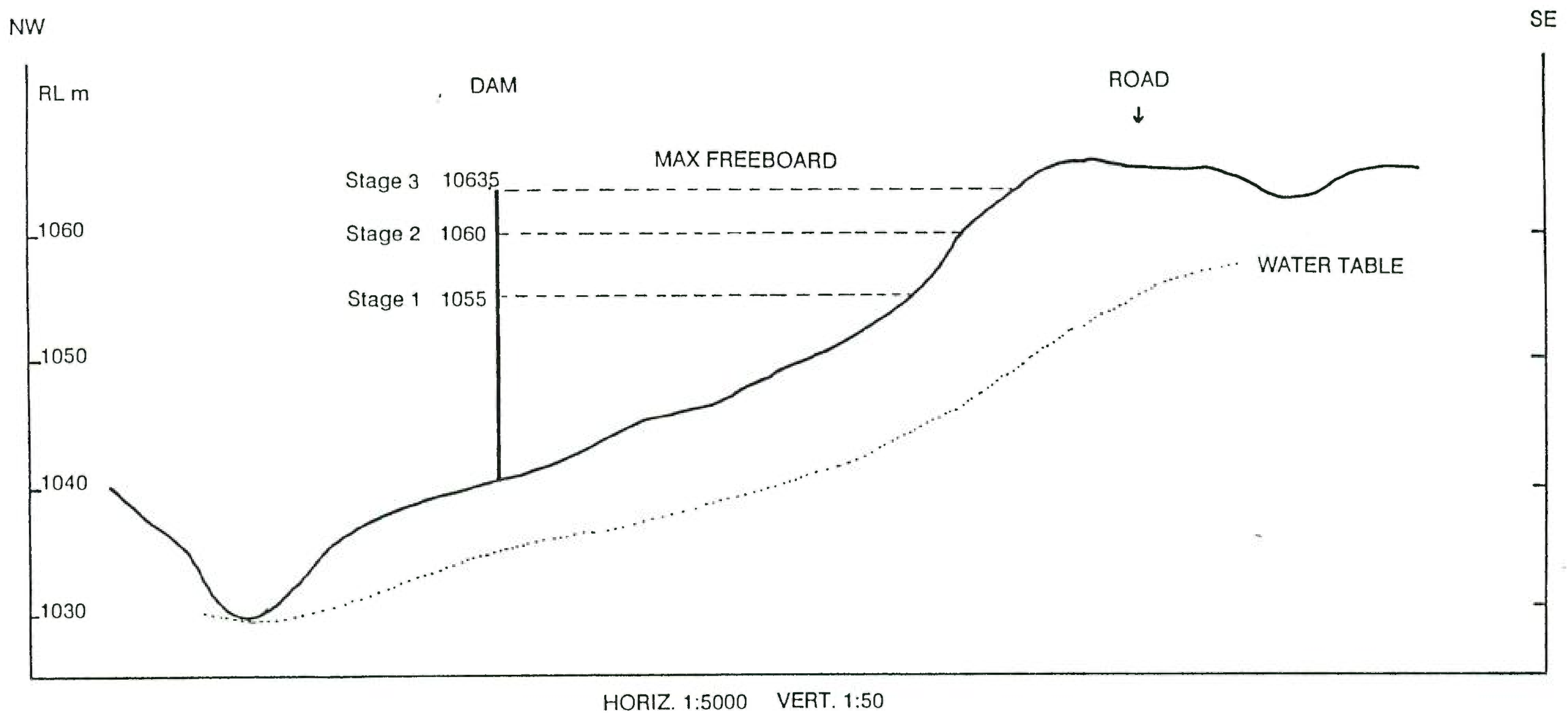
WATER TABLE CONTOURS

FIG 1



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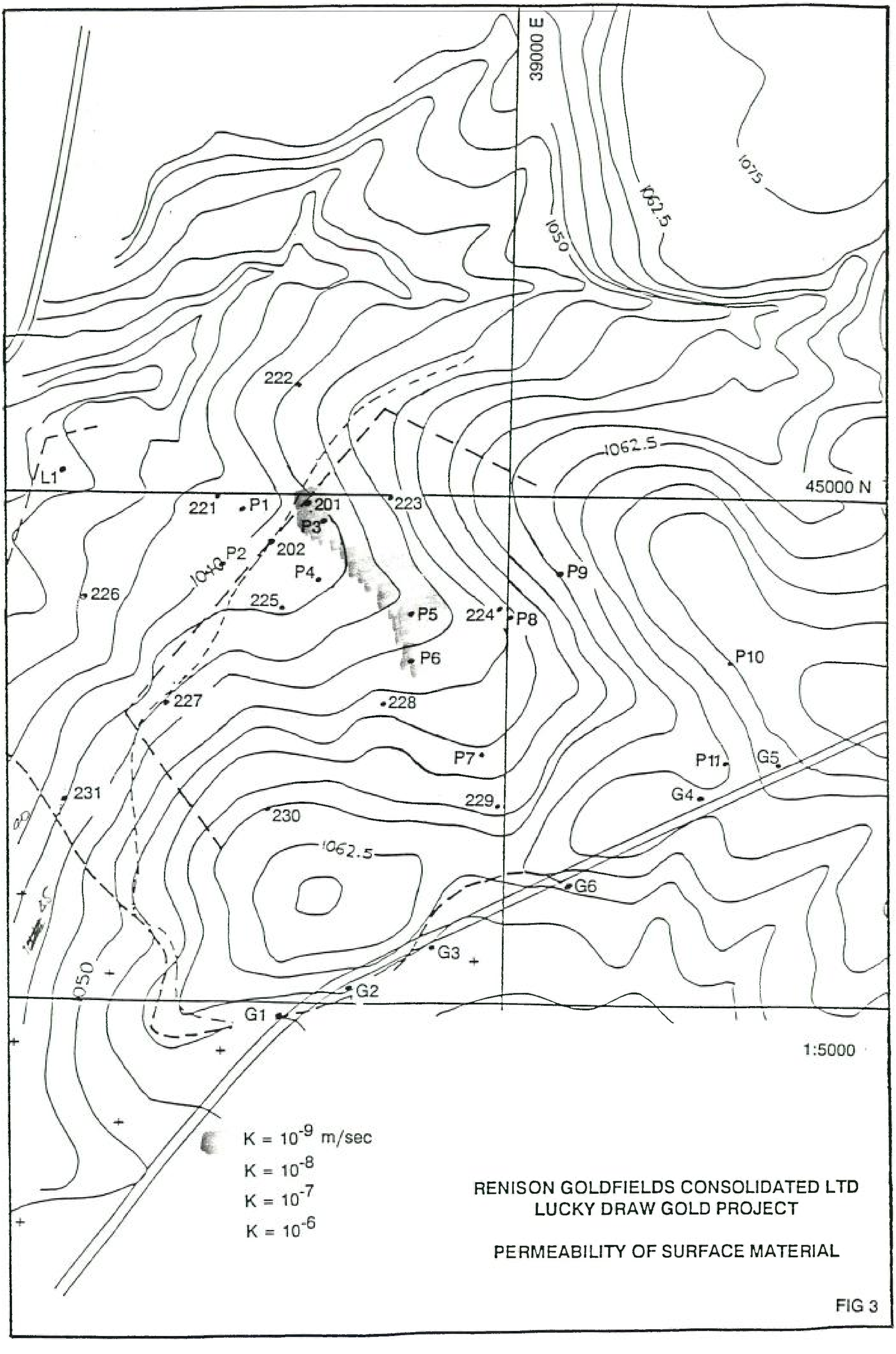
HYDROGEOLOGICAL CROSS-SECTION

FIG 2



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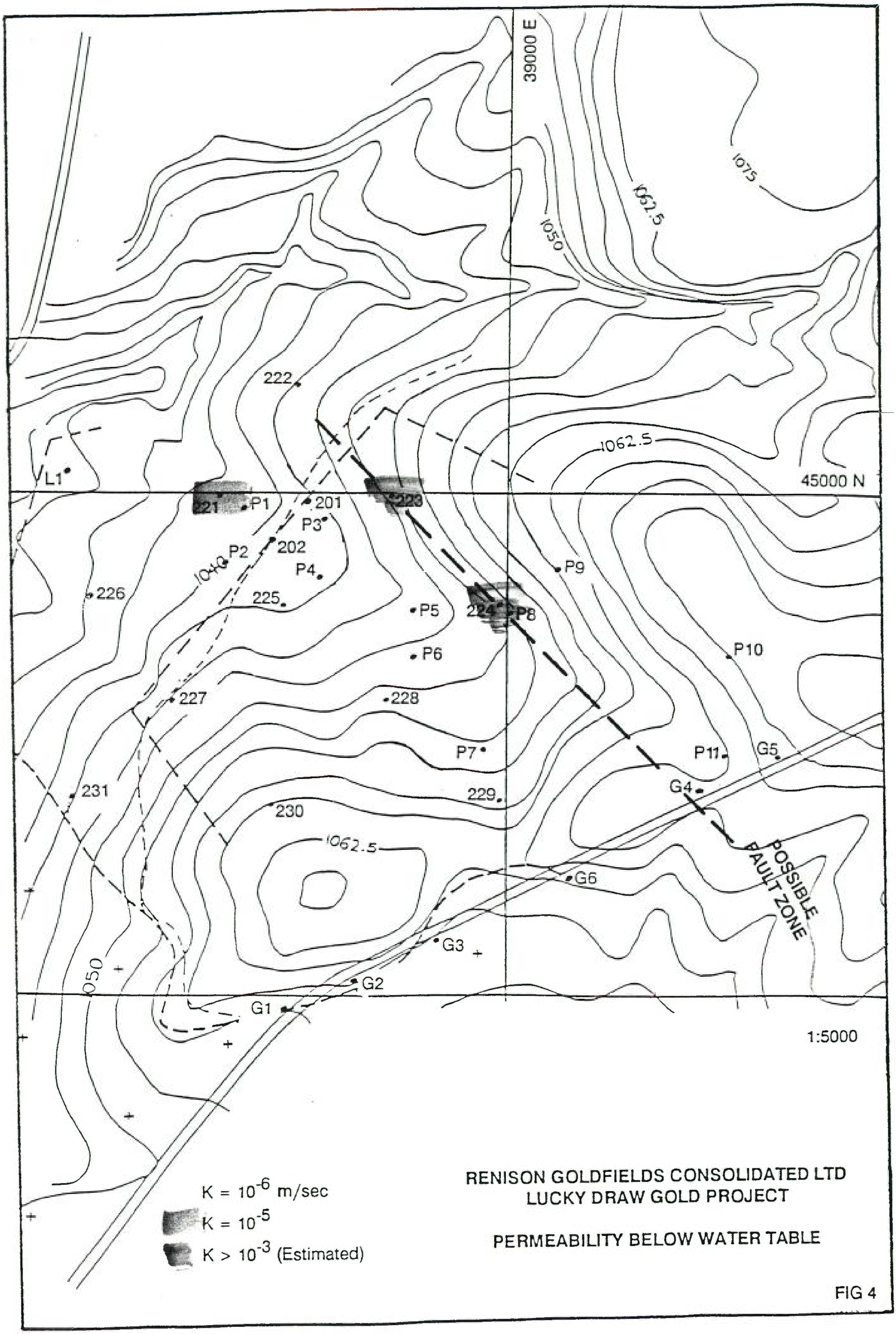
PERMEABILITY OF SURFACE MATERIAL

FIG 3



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PERMEABILITY BELOW WATER TABLE

FIG 4

APPENDIX

BORE LOGS

INTERPRETED GEOLOGICAL LOG

BORE GRANITE 1

Interval (m)	Description
0 - 1.9	Clay, red-brown, with fine sand, micaceous becoming lighter in colour towards bottom of section (weathered granite).
1.9 - 5	Clay, white, sandy, with pebbles (1-2 mm) of clear and milky rounded quartz, abundant mica, kaolinitic, soft, damp (weathered granite).
5 - 6.9	Granite, white, partially weathered, harder, with coarse quartz grains and fine feldspars. Fresher and harder towards the base.
6.9	Bottom of hole.

INTERPRETED GEOLOGICAL LOG

BORE GRANITE 2

Interval (m)	Description
0 - 2.9	Granite, red-brown, highly weathered with Fe oxide stains, micaceous, fine grained, changing to lighter red then pink with depth.
2.9 - 3.9	Granite, white mostly, but with fine layers of yellow and red orange bands. Weathered, clayey.
	4.6 kaolinitic clay with mica and fine sand
	5.5 harder band
	6.5-6.6 red-orange
	6.6-8.9 alternating soft and hard bands, clayey.
8.9 - 11.9	Granite, white-yellow, becoming fresh, a red-orange band at 11.8-11.9 m.
11.9 - 13	Granite, white, fresh and hard.
13	Bottom of the hole.

INTERPRETED GEOLOGICAL LOG

BORE GRANITE 3

Interval (m)	Description
0 - 0.5	Soil, grey-brown, sandy.
0.5 - 1.8	Granite, light brown, highly weathered, micaceous with fine quartz grains.
1.8 - 5.5	Granite, white-yellow, abundant mica, rounded quartz milky and clear pebbles. Clayey. 2-3 coarser texture, somewhat clayey. 4.6 brown-yellow, a possible fine fracture with Fe oxides.
5.5 - 9	Granite, pink-brown, otherwise mostly as above, fine texture and highly micaceous.
9 - 10	Granite, white, fine grained, fairly hard at 9.3 m.
10	Bottom of the hole.

INTERPRETED GEOLOGICAL LOG

BORE GRANITE 4 (LPH 301)

Interval (m)	Description
0 - 2.2	Clay-Silt, red-brown, soft to medium, becoming yellower towards bottom of section. Semiplastic.
2.2 - 12.5	Siltstone, orange, fine, well sorted, rounded, clear quartz grains, with Fe oxide and minor clay. Showing some variation of colour with depth. Generally soft and friable. 3.9 lighter in colour 5-6 darker 10-11 pink red (salmon) 11-12 darker 12.5 water at change of rod.
12.5	Bottom of hole.

INTERPRETED GEOLOGICAL LOG

BORE GRANITE 5 (LPH 302)

Interval (m)	Description
0 - 2.6	Clay, dark red, stilt, silty, some siltstone fragments towards the bottom of the section.
2.6 - 19.0	Siltstone, yellow, fine, well sorted, clear, rounded quartz grains, minor clay colour variations throughout. Fine mica fragments present. 4 pink red 5 light pink-white 6-7 white-yellow-pink 9.6 a red band (minor fracture?) 10-12 yellow-white 13 brown micaceous 13-19 brown bands 16 moist.
19	Bottom of the hole. Airlifted muddy water.

The form in which cyanide will occur in the tailings is difficult to predict. The cyanide may be chemically or physically absorbed on tailings material or may react with constituents within the tailings or underlying material. Free cyanide occurs only rarely in nature because of the high reactivity of the molecule.

Mechanisms that may lead to reduced cyanide levels are:

i) Complexation Reactions

Cyanide may react with metal ions in water to form ligand complexes, eg.,

$$Fe^{+3} + 6CN^{-} = Fe(CN)^{-3}_{6}$$

In the absence of strong sunlight, such complexes are stable (Cotton and Wilkinson, 1980), so that "free" cyanide in solution may be significantly reduced by the availability of metal ions such as iron. For these conditions, the toxicity of the tailings pond will decrease commensurately. However, the "total" concentration of cyanide is not reduced and the complexed cyanide could be freed by exposure to strong sunlight.

ii) Volatilisation

Tailings generally have initial pH values above 10. As they react with the neutral or acid environment in the dam the pH drops. At pH values below 9, CN^{-} is converted to HCN, which is volatile and is lost from the tailings water as gas. This volatilisation acts to remove CN^{-} from the tailings water. At the seepage travel rates expected from the tailings pond, this reaction is expected to reduce the cyanide concentration in the tailings water prior to groundwater interception.

iii) Adsorption Reactions

Adsorption of cyanide onto mineral surfaces or coprecipitation with metal ions during groundwater flow often causes major reductions in cyanide concentration of infiltrating groundwaters. (Huiatt, 1985). This adsorption or precipitation may be irreversible, leading to permanent reductions in cyanide levels, or reversible. In the latter case, cyanide is being continually adsorbed and released during groundwater travel. This acts to retard cyanide flow, relative to the rate of groundwater flow.

iv) Formation of Thiocyanate

The reaction of cyanide with sulphur (derived from the soil or via bacterial effects) results in the formation of the comparatively non-toxic thiocyanate.

The reaction is:

$$CN^- + S = CNS^-$$

Thiocyanate may be further decomposed by bacteria.

v) Bacterial Degradation

Cyanide may be degraded by bacteria into harmless carbon dioxide and ammonia. It is likely that such bacteria will occur in the soil and weathered rock at this site.

9.6 <u>Other Considerations</u>

The existing groundwater flow gradient beneath the proposed empoundment is towards Hackney Creek. A check of DWR records indicated that there are no licensed extractions in Hackney Creek other than that for RGC (R.W. Corkery, pers. com.). The final tailings disposal area will encroach back from the proposed dam wall towards the catchment divide, and a saddle dam is planned on the southern perimeter. It is probable that the topographic divide also coincides with a groundwater flow divide and that groundwater on the southern side of the divide flows towards Thompson Creek, containing the Burraga water supply dam. It is possible that towards the end of the empoundment life the head superimposed on the natural groundwater gradient will allow some seepage to migrate in this direction.

9.7 <u>General Discussion</u>

Seepage rate estimates have been carried out based on all currently available information.

Seepage quantities (25 m^3/day to 300 m^3/day) from the proposed tailings empoundment are estimated to be within the same order of magnitude of the natural groundwater flow beneath the storage area. Calculated travel time to reach the location of Hackney Creek downstream of the empoundment vary from 18 months to 20 years, and are dependent on permeability assumptions.

This seepage, carried with groundwater flow, should be at a lower elevation than the existing creek bed at the confluence with Hackney Creek and therefore should not enter the creek at this location. Reported springs throughout the area suggest that it is probable that groundwater does enter the creek elsewhere and it is likely that the groundwater flow carrying the seepage enters the creek further downstream. All travel estimates have been based on no preferred flow paths beneath the tailings; this cannot be guaranteed due to the geology at the site containing strong lineaments. It is, however, considered that the higher permeability values used in the analysis are upper bounds and therefore the results make some compensation for potential fracture flow.

Seepage from this site following attenuation, absorption, groundwater dilution and surface water dilution may not be hazardous. However, insufficient site specific information is currently available to support this and therefore difficulties will arise in receiving acceptance of the EIS.

To further evaluate the site it is recommended that testing be carried out on the tailings, tailings liquor and underlying materials to assist in the estimation of cyanide travel from the tailings. This would involve column testing of materials. The site geology should also be reviewed.

Further hydrological analysis of the tailings empoundment is also required to verify the seepage model. This would be best carried out by computer modelling of the empoundment and natural aquifer. A saturated/unsaturated flow model would be required. This could also be used to develop management philosophies for the tailings empoundment operations, such as possible underdrainage for interception of tailings seepage.

However, prior to carrying out further studies on this site under the proposed method of empoundment it is recommended that consideration be given to the cost effectiveness of the following alternatives:-

- Neutralisation of tailings and liquor prior to disposal.
- Methods of tailings empoundment for complete internal drainage.
- Review of alternative tailings disposal sites.

10.0 SUMMARY AND CONCLUSIONS

Groundwater occurs in fracture permeability in and around the mine prospect, and at depths up to 20 m depending upon surface topography. The average rock permeability and storage capacity are low and no large underground flows can be expected.

The proposed mine and tailings dam sites are near a local catchment divide. Groundwater flow directions are generally to the northwest and discharge may occur to Hackney Creek as springs at lower reaches below the mine. Groundwater tested was generally of potable quality.

The proposed open pit mine will extend below the water table and pit inflows will occur. Inflow estimates are given showing an initial rate of 90 m^3/day at the end of year 1, increasing to 270 m^3/day at the end of mining in year 4. These estimates are considered accurate to $\pm$ 50%.

Groundwater inflow to the pit could lower the surrounding water table by amounts decreasing with distance from the pit. At a distance of 1.5 km and beyond the affect of mining is estimated to be too small to monitor compared to normal seasonal rainfall variations. The nearest existing groundwater user is 3.5 km from the pit and should not be affected by mining.

Seepage from the tailings empoundment is likely to occur with the proposed design and management practice. Although seepage rates are small it may be possible for leachate to reach and discharge to Hackney Creek.

The main hazard in the leachate is free cyanide. Estimates are available for the amount of total cyanide discharged to tailings but no tests have been done to estimate the amount of cyanide in the seepage water or in groundwater along the seepage paths. Chemical and physical restrictions may reduce the cyanide to nil or acceptable levels in the seepage path. However, further testing is required to support this possibility.

Prior to carrying out these chemical studies a study is recommended on alternative procedures of tailings disposal as follows:-

- Neutralisation of tailings and liquor prior to disposal.
- Methods of tailings empoundment for complete internal drainage.
- Review of alternative tailings disposal sites.

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TABLE 1

MEAN MONTHLY RAINFALL RECORDS

	OBERON PRISON CAMP mm	BLACK SPRINGS mm	BUCKBURRAGA mm
JANUARY	90	77	47
FEBRUARY	76	63	33
MARCH	71	59	44
APRIL	71	55	49
MAY	82	70	58
JUNE	98	77	30
JULY	88	76	68
AUGUST	93	85	73
SEPTEMBER	81	74	85
OCTOBER	91	86	73
NOVEMBER	83	75	61
DECEMBER	76	67	62
YEAR	1000	864	651
YEARS OF RECORDS	50	47	5

TABLE 2

AIRLIFT TESTS RESULTS

BORE	AQUIFER THICKNESS m	PERMEABILITY m/d	TRANSMISSIVITY m^2/d
146	60	5.2×10^{-3}	0.31
148	60	35×10^{-3}	2.1
150	60	4.3×10^{-3}	0.26
154	60	3.5×10^{-3}	0.21
175	60	26×10^{-3}	1.6
202*		1.4×10^{-1} - 5.3×10^{-1}	

* Don Douglas and Partners Pty. Ltd. report Dec. 1987.

Bore 169: A slug of water of 75 L was removed at the start of the test, but no recovery occurred (from a depth of 47.9 m).

Aquifer thickness means saturated thickness to R.L. of pit bottom (R.L. 960).

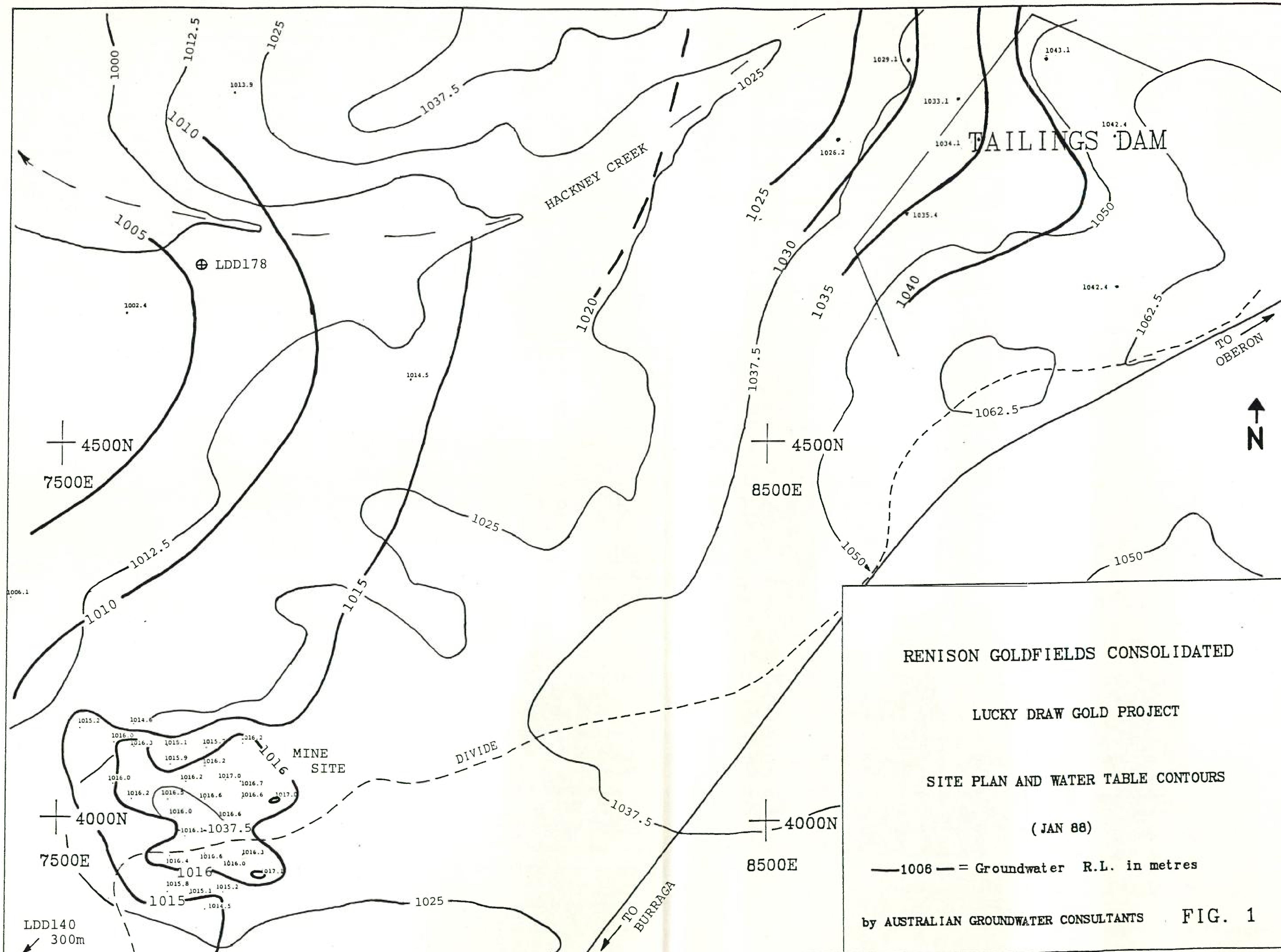
TABLE 3
WATER ANALYSIS

Drill hole	LXD140 outside pit (flowing)	LDD146 within pit	LDD154 within pit	LDD165 within pit	LDD178 Hackney's Ck (flowing)
Conductivity (25^{o}C umhos cm^{-1})	2100	530	660	340	1000
pH	6.8	6.4	6.5	5.9	6.4
Na (mg/L)	130	28	32	26	115
K (mg/L)	6.0	4.6	7.3	2.8	6.1
Ca (mg/L)	55	8.9	14	4.1	53
Mg (mg/L)	174	47	63	19	55
Cl (mg/L)	435	35	45	60	55
HCO_3 (mg/L)	530	240	335	80	690
SO_4 (mg/L)	45	25	13	10	15
Total Alkalinity (mg/L)	430	200	275	65	565
Non Filterable Residue (mg/L)	4	80	325	20	95
As (ug/L)	4.5 6.0	0.5 2.0	0.5 2.0	<0.5 <0.5	<0.5 <0.5
Cu (ug/L)	5.5 8.0	64 112	29 59	14 41	5.0 6.0
Pb (ug/L)	10 15	52 170	30 66	19 36	9.5 11
Zn (ug/L)	7.5 10	92 165	125 160	31 77	20 82
Mn (ug/L)	22 31	265 940	465 1410	1760 2140	17 56
Cd (ug/L)	1.0 1.3	0.5 0.75	0.65 0.85	0.35 0.55	0.65 1.2
Bi (ug/L)	<.05				
Fe (mg/L)	<.01 0.02	0.14 1.31	0.1 0.98	0.12 0.38	0.05 0.04

TABLE 4

TAILINGS DAM DRILL HOLE SUMMARY

HOLE NO.	WATER INTERSECTED (m) (Approx.)	STANDING WATER LEVEL 19/1/88 (m)	BASE OF WEATHERING (m)
LDD202	?	7.4	16.75
LRC221	~38	5.9	26
LRC222	~13	8.3	22
LRC223	~13	6.9	16
LRC224	~17	10.6	20
LRC225	Dry	8.4	16
LRC226	~27	9.3	26
LRC227	~29	12.1	+32
LRC228	Dry	Collapsed	+18
LRC229	Dry	14.6	+18
LRC230	Dry	31.2	26
LRC231	~30	Oil in hole	46



RENISON GOLDFIELDS CONSOLIDATED

LUCKY DRAW GOLD PROJECT

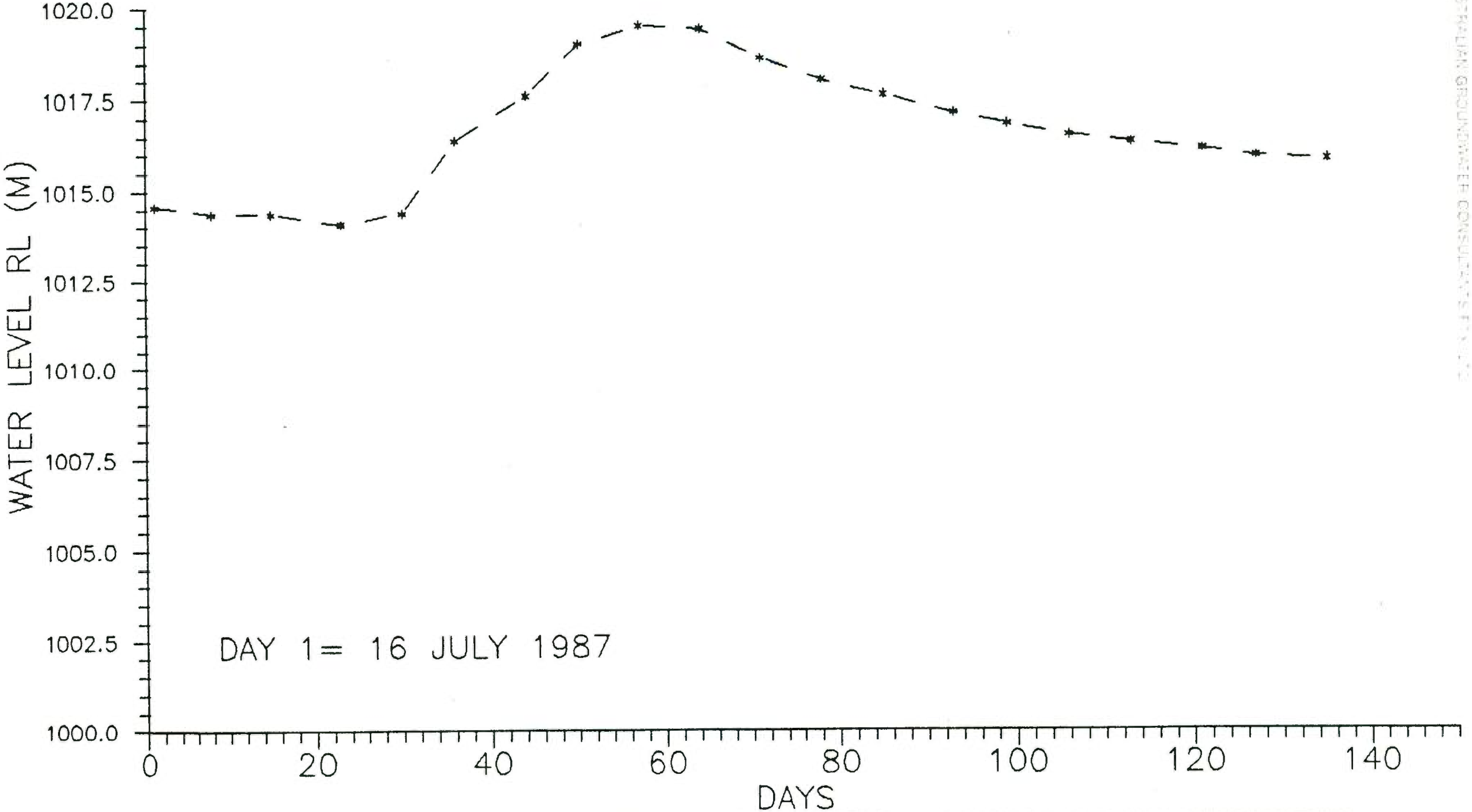
SITE PLAN AND WATER TABLE CONTOURS

(JAN 88)

—1006— = Groundwater R.L. in metres

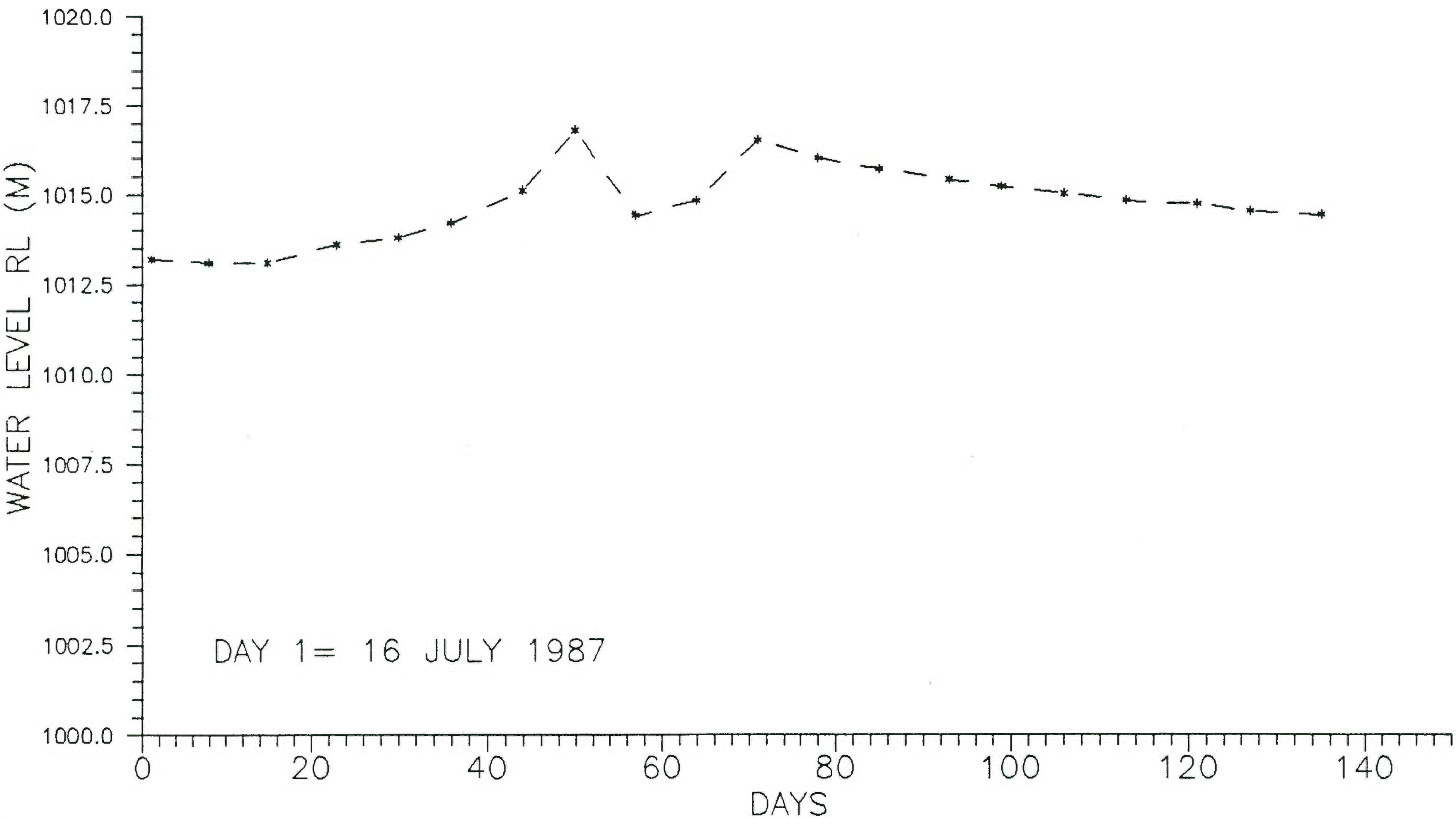
by AUSTRALIAN GROUNDWATER CONSULTANTS

FIG. 1



RENISON GOLDFIELDS CONSOLIDATED LUCKY DRAW PROSPECT
HOLE NO 149

FIG. 2



RENISON GOLDFIELDS CONSOLIDATED LUCKY DRAW PROSPECT
HOLE NO 151

FIG. 3

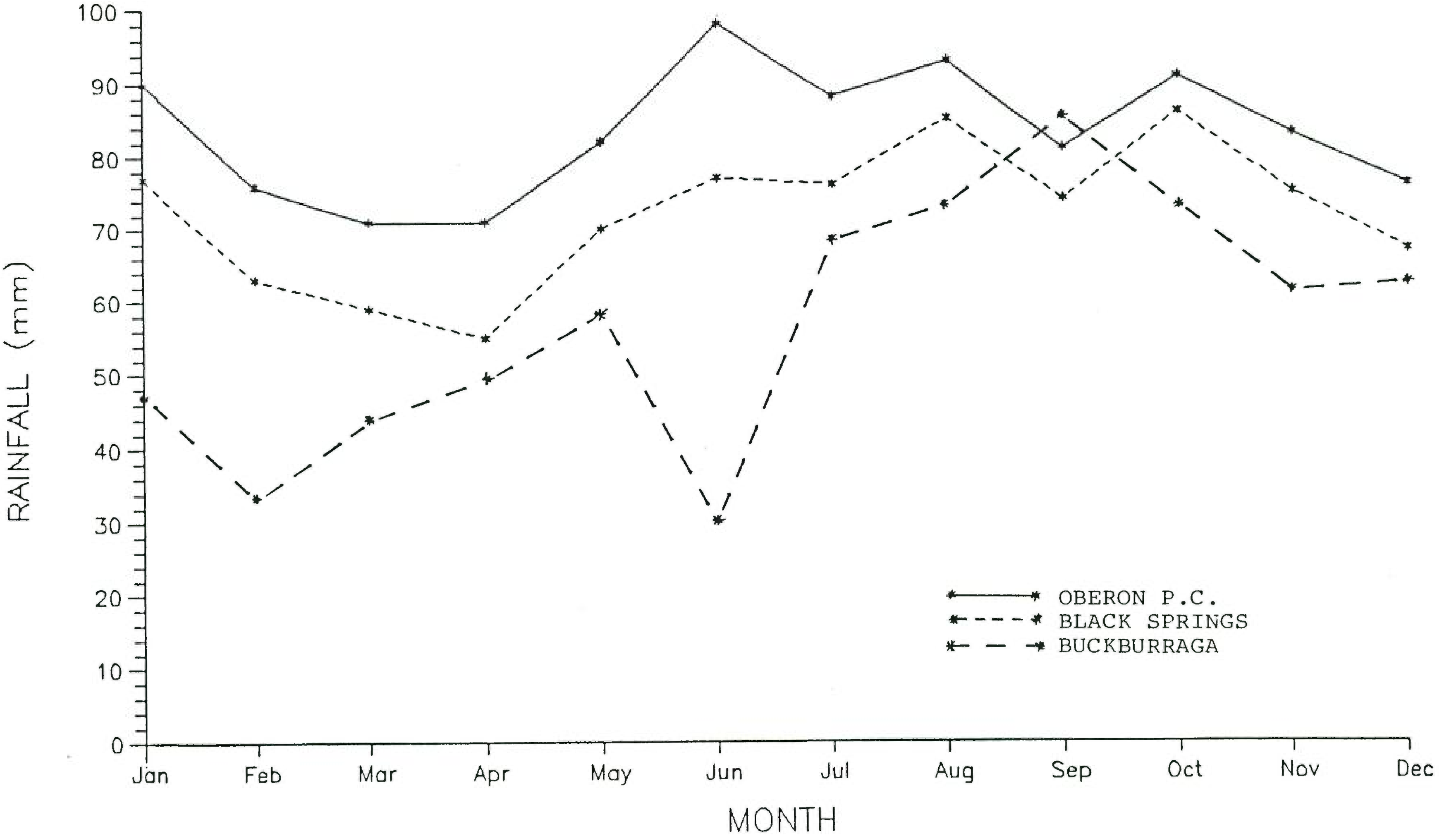
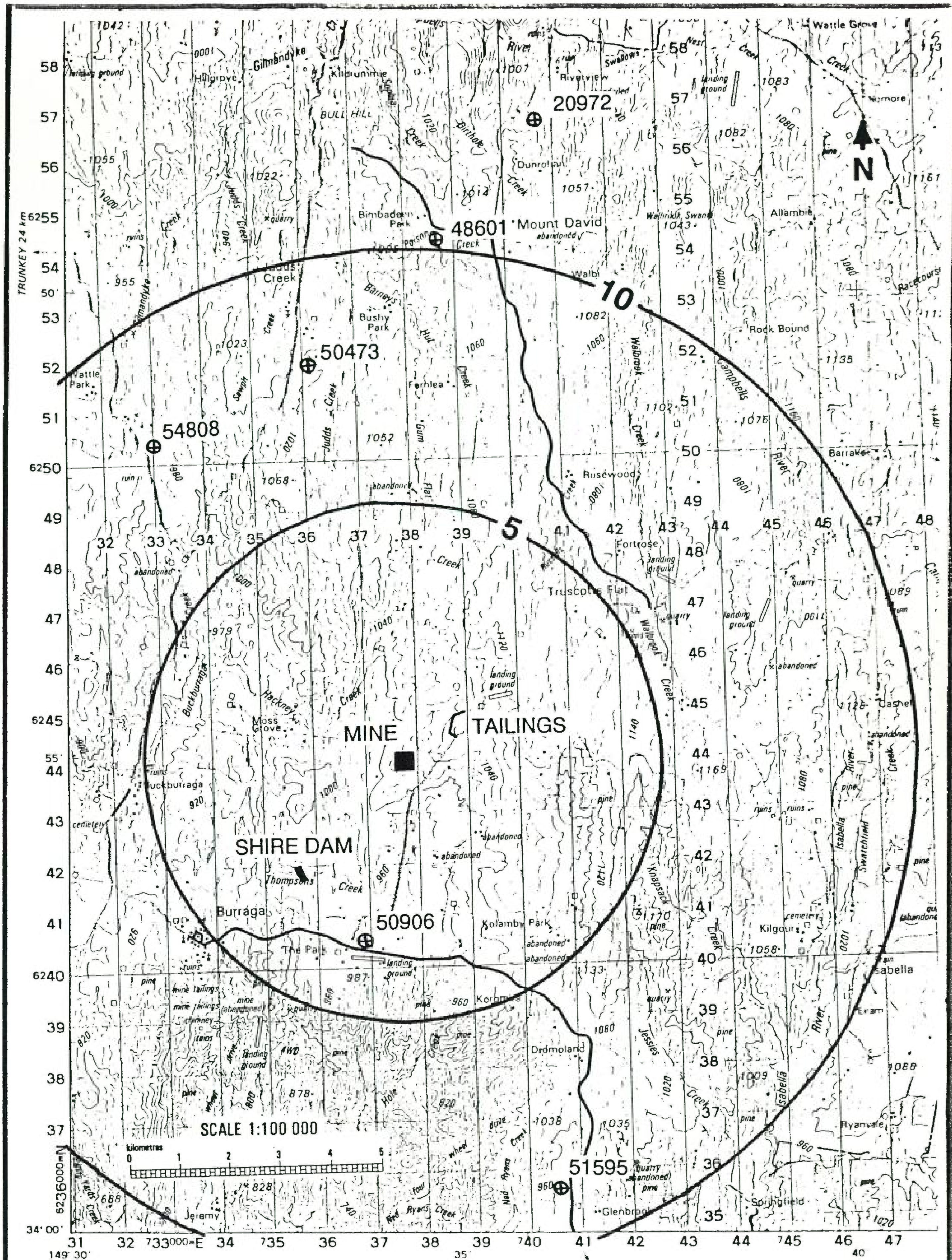


FIG. 4

RENISON GOLDFIELDS CONSOLIDATED LUCKY DRAW PROSPECT
MEAN MONTHLY RAINFALL



AUSTRALIAN GROUNDWATER CONSULTANTS PTY. LIMITED

RENISON GOLDFIELDS CONSOLIDATED

LUCKY DRAW GOLD PROJECT

REGISTERED BORES LOCALITY PLAN

DATE FEB '88	DWG. Nº. 3044/5	FIG. Nº. 5

APPENDIX II

TIME LAG TESTS

INTERPRETED GEOLOGICAL LOG

BORE GRANITE 6

Interval (m)	Description	
0 - 0.8	Siltstone, red micaceous, minor coarse fragments, soft, Fe oxides.	
0.8 - 12.3	Granite, pink white, micaceous, fine to medium clear and milky subrounded quartz grains. Some coarse fragments. Weathered.	
	2-3	white-cream
	5	yellow
	5-6	coarse quartz grains and fragments
	6.5	a small band of dark orange (fracture with Fe oxide)
	7-12.1	yellow orange - harder drilling
	12.1 - 12.3	whiter-hard.
12.3	Bottom of the hole.	

INTERPRETED GEOLOGICAL LOG

L1

Interval (m)	Description
0 - 0.15	Soil, dark grey, silty, sandy.
0.15 - 1.9	Sand, dark red, silty, minor clay, fine, sub-rounded clear quartz grains with Fe oxide coating. A fine layer of gold yellow clay at the bottom.
1.9 - 3.5	Clay, brown, soft, moist, plastic, sticky, with abundant large and angular quartz chips.
3.5 - 4	Sand, yellow-orange-red, fine rounded clear quartz grains, silty, minor coarse pebbles, minor clay.
4 - 15	Siltstone, orange, fine clear well sorted quartz grains and occasional rounded quartz pebbles. Minor clay. Firm. 6-7 buff, with layers of orange and red (fractures?) and finer. 10-11 a fine layer of dark brown material with small black grains. 13 Water at change of rods and a layer of coarse rounded pebbles, up to 40 mm.
15 - 23	Siltstone, grey, very fine to powdery, minor mica, harder than above. Some albite pebbles.
23 - 24	Siltstone, grey, darker with very fine sand.
24 - 27	Sandstone, grey, very fine clear quartz grains, albite pebbles.
27 - 29.5	Siltstone, grey, darker, 28 slightly coarser.
29.5	Bottom of the hole.

GEOLOGICAL LOG

BORE PERMEAMETER 1

Interval (m)	Description
0 - 0.9	Clay, red, silty, sandy, hard.

BORE PERMEAMETER 2

Interval (m)	Description
0 - 0.3	Soil, grey, sandy, silty.
0.3 - 0.5	Sand, grey, clayey.
0.5 - 0.9	Clay, red-brown, silty, hard.

BORE PERMEAMETER 3

Interval (m)	Description
0 - 0.3	Soil, grey, sandy, clayey.
0.3 - 0.9	Clay, red-brown, stiff, hard.

BORE PERMEAMETER 4

Interval (m)	Description
0 - 0.35	Soil, grey, silty-sandy.
0.35 - 0.9	Clay, red-brown, hard, brittle.

BORE PERMEAMETER 5

Interval (m)	Description
0 - 0.1	Soil, grey-brown, silty.
0.1 - 1.0	Clay, red-brown, hard, stiff.

BORE PERMEAMETER 6

Interval (m)	Description
0 - 0.1	Soil, grey, brown.
0.1 - 1	Clay, red, sandy, hard.

BORE PERMEAMETER 7

Interval (m)	Description
0 - 0.1	Soil, grey, brown, sandy.
0.1 - 0.03	Clay, red, hard, sandy, with granite and quartz fragments at 0.8 - 0.93.

BORE PERMEAMETER 8

Interval (m)	Description
0 - 0.1	Soil, grey, brown, sandy.
0.1 - 1.0	Clay, red-orange, sandy with quartz fragments.

BORE PERMEAMETER 9

Interval (m)	Description
0 - 0.1	Soil, grey, some yellow-brown clay, sandy.
0.1 - 0.9	Clay, red-brown, with quartz fragments, sandy.

BORE PERMEAMETER 10

Interval (m)	Description
0 - 0.2	Soil, grey-brown, sandy.
0.2 - 0.96	Clay, red, sandy, somewhat plastic.

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MEMORANDUM/FAX

AUSTRALIAN GROUNDWATER CONSULTANTS PTY LIMITED	DEST. No: 2126252	DATE: 2.6.88
	JOB No: 3044/2	No. of PAGES: 4

TO

NAME Bob McGloughlin

COMPANY Kinhill

Originating Office ✓	SYDNEY ✓	MELBOURNE	PERTH	BRISBANE	ADELAIDE	DARWIN
PHONE No.	(02) 929 4611	(03) 529 3211	(09) 362 4322	(07) 393 1533	(08) 31 0647	(089) 27 6937
FAX No.	(02) 959 4160	(03) 529 3003	(09) 361 4872	(07) 391 8019	(08) 332 9310	(089) 27 6615

SENDERS NAME: Frank Mohen.

SUBJECT: Lucky Downs

Bob,

summary follows.

Regards

Frank

MEMORANDUM/FAX

AUSTRALIAN GROUNDWATER CONSULTANTS PTY LIMITED	DEST. No: 2350603	DATE: 2.6.88
	JOB No: 304-1/2	No. of PAGES: 3

TO

NAME Nick Humphry/John Butler

COMPANY RGC

Originating Office ✓	SYDNEY	MELBOURNE	PERTH	BRISBANE	ADELAIDE	DARWIN
PHONE No.	(02) 929 4611	(03) 529 3211	(09) 362 4322	(07) 393 1533	(08) 31 0647	(089) 27 6937
FAX No.	(02) 959 4160	(03) 529 3003	(09) 361 4872	(07) 391 8019	(08) 332 9310	(089) 27 6615

SENDERS NAME: Frank Mohen/Stuart Miller

SUBJECT: Lucky Draw Tailings Study

2nd June, 1988

Our Ref: FM:mz:tailings.mem

Copy to: Bob McGloughlin - Kinhill Engineers

Further to recent discussions with yourself and, in more detail, with Bob McGloughlin (Kinhill Engineers) we provide the following point summary.

1.0 AGC in conjunction with Stuart Miller and Associates (SMA) have carried out geochemical testing on the tailings and underlying soils. Samples of tailings and liquor were provided by RGC to Fox Anamet laboratories for preparation. Directions on preparation (verbal) were provided to Fox by AGC/SMA.

The aim of the testing was to determine:

a) Expected degradation of Cyanide (total and free) during the beaching of tailings.

b) Expected degradation of Cyanide in entrained liquor (total and free) during migration through the tailings.

c) Expected degradation/interaction of Cyanide in pore water (total and free) during seepage through the underlying soils (surficial soils and deeper weathered sandstone).

2.0 Following approximately 1 month of testing it was noted that expected degradation in the tailings liquor for the beaching test was not occurring to the degree expected and that the surficial soils were lowering concentrations dramatically over an extended period of time. These results were examined in detail and a relatively high Fe content was the expected cause of the lack of degradation in the beaching test. Other available liquor/ore characterisation was reviewed and found not to have a similar Fe content. Further investigations revealed that the primary ore sample which had been used for the testing was prepared using mild steel balls in the milling process. This was not as planned and has been found to give anomalous results in the past. Due to this, the encouraging performance of the surficial soils in decreasing cyanide was considered questionable.

3.0 In order to assess the contribution of the anomalous Fe to the observed immobility of the cyanide in solution, the surficial soils testing was recommenced using a synthesised cyanide liquor containing no Fe.

The results were quite different and the cyanide was found to breakthrough the soils column in 2 pore volumes (compared with 16 pore volumes for the previous testing). This suggests that cyanide will be relatively mobile in seepage through these materials.

4.0 Due to these results the following comments are offered:

a) Cyanide contamination of the groundwater is likely and thus cyanide levels in the tailings should be reduced to low levels to minimise long term risks of expensive groundwater cleanup.

b) The first step in minimising the cyanide concentration is to promote effective beaching of the tailings to allow for maximum natural degradation through volatilisation to the atmoshphere. This is believed to be difficult (Kinhill) due to constraints of area associated with the site.

Beach recycle times of not less than 7 days are expected to be required based on previous testing on other projects. This should be confirmed by testing of a prepared sample without Fe contamination.

c) To ensure low concentrations of cyanide the treating of the tailings liquor prior to discharge should be considered. This may be required over the total project life or just for the period during which insufficient beaching time is available, pending the results of further testing.

d) Interception bores in line with the tailings dam wall are considered a viable control option although may require operation for long periods after decommissioning. The time required would be dependent on the rate and concentrations of cyanide reaching the water table. To estimate this time period with confidence and to assess sensitivity to parameters such as the possible fault zone - computer modelling of the storage should be carried out as proposed in previous correspondence (29 February 1988).

e) As discussed (Stuart Miller) with John Butler fresh samples are being prepared for the beaching and insitu degradation testing and will be forwarded to SMA.